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EFFECT OF SHORT WAVE DIATHERMY ON INTESTINAL ACTIVITY *

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Since the first medical treatment with short wave diathermy was administered by Schliephake[1] in March, 1929, it has been claimed that countless diseases and conditions have been cured through its use. Short wave diathermy has been advocated for the treatment of innumerable diseases and pathologic conditions from cancer to seborrhea capitis. Many of these claims of cures are without adequate basis and have been prompted, in all probability, by too much enthusiasm. For example, the problem of constipation has received its share of the spotlight without any apparently logical basis for the use of short wave diathermy and regardless of the type of constipation or intestinal condition. Very little work has been done on the action of short wave diathermy on intestinal motility, and many difficulties are presented by this problem. It is not with the idea of unfolding some hitherto unknown property of short wave diathermy, but rather in an effort to close in the gap in this particular phase of experimental medicine that this study has been undertaken.

Procedure

Experimental studies were made on dogs with exteriorized loops of small intestine covered with skin. This bipedicled loop was particularly adaptable for the present work because it was in continuity with the rest of the bowel and the nerve and blood supply remained intact, thus preserving as much as possible the normal physiologic state. Each animal then was trained thoroughly to lie quietly on its left side.

A Lucite tambour was attached to the loop with a piece of soft kid leather and held securely by adhesive tape. The Lucite tambour was used to prevent overheating and possibly burning of the skin, as might happen if a metal tambour were placed in a high frequency electric field. A rubber tube connected the appliance to a kymograph and a chronograph recorded the time at five second intervals. The diathermy apparatus used was a small portable outfit employing a single 250 watt oscillator tube with an output of approximately 150 watts and a wavelength of approximately 7 meters.

The pad technic was employed for applying the short wave diathermy. One large pad was placed beneath the cotton mattress, which thus served as a spacer. Another pad was placed on the upper side of the animal and cotton toweling was used for spacing. The diathermy thus was applied from side to side. Throughout the experiment there seemed to be no discomfort to the animal, and no burns or other untoward events occurred.

Many normal tracings of the intestinal motility of each animal were made. These consisted of recordings of the motility at various times of day, before and after feeding, and also after twenty to twenty-four hour, forty-eight and seventy-

* Read Before the Nineteenth Annual Meeting of the American Academy of Physical Medicine, New York, New York, April 29, 1941.

two hour fasts. The type of activity of the movements were noted in these cases for comparison with the motility under the influence of short wave diathermy. Graphs were made as were studies of peristalsis under all normal conditions, including observations while the animal was being fed on the table.

Effect of Outside Influences

Various minor details, such as psychic influence, tail wagging and respiratory motions, were considered in the estimation of the results. Slight movements, such as respiratory motions, tail wagging or the moving of the head or the paws, had no effect on the record. The presence of strangers or another dog in the room did not seem to influence the result. Reprimands did not affect the motility. Noises sharp enough to startle the animal when it was dozing, such as the slamming of a door, usually made it jump and sometimes caused a cessation of motion of the intestines for about ten to fifteen seconds, following which the normal motility would return. The sight of food usually caused an almost immediate contraction and increase in the tonus of the bowel, particularly if the animal was hungry. If the animal was not hungry, there was usually little effect noted. As was reported by Douglas and Mann,[2] after the ingestion of food there is a wave of activity traveling down the length of the small intestine. The initial rise in the amplitude occasioned by the sight of the food develops into a series of peristaltic movements lasting a variable time (fig. 1).

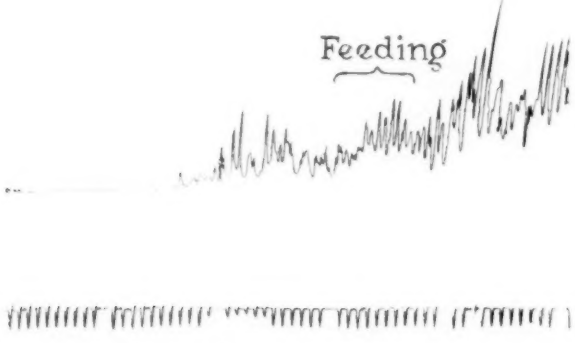

Fig. 1. — Effect of feeding on motility.

Methods of Study

Gross Observations. — The movements of the intestine can be readily seen as they pass the loop, and their direction can be easily ascertained. In all gross observations of the ileal loops no evidence of antiperistalsis was noted. However, the various types of movements were fairly easily distinguishable and palpation of the loop usually tended to corroborate the visual evidence. Since the loop of ileum lies directly beneath the skin of the exteriorized loop but is not attached to it, this segment of intestine can be palpated almost as well as though it were lying exposed. Some movements are difficult to translate, however, and it was this difficulty of interpretation which led to the abandonment of gross observation as a means of studying effects after application of the short wave diathermy.

Roentgenoscopic Studies. — The final method of study was roentgenoscopic examination of the bowel following preparation with an opaque medium as described by Steggerda and Gianturco.[3]

Temperature Studies. — Rectal temperatures were taken at regular intervals to determine the effect of short wave diathermy on the systemic temperature of the dog. The application of short wave diathermy for thirty to forty minutes caused the animal to pant at a rate between 250 and 300 respirations a minute.

As Hemingway and Barbour[4] have shown, panting begins when a definite caloric dose has been given. In the majority of cases, the systemic temperature rose slightly, averaging between 0.4 and 0.5 F. Occasionally there was a slight drop from the initial temperature (table 1).

TABLE 1. — *Effects* of Short Wave Diathermy on the Bodily Temperature of Dogs (in Degrees Fahrenheit).*

Animal	Initial Temperature	Before Diathermy	Diathermy Started and Run for 20 Min.	30 Min.	40 Min.	1 Hr.
1	101.1	101.1	101.4	.....	101.6	.....
2	101.0	101.1	.....	101.4	.....	.....
2	101.1	101.1	.....	101.4	.....	.....
3	101.4	101.5	101.6	101.8	101.8	101.7
3	101.2	101.1	.....	101.3	.....	.....
4	101.0	101.0	.....	101.4	.....	101.4
4	101.1	101.1	.....	101.4	.....	.....
1	101.2	101.2	101.4	.....	101.9	.....
5	101.4	101.4	.....	101.9	.....	.....
6	102.4	102.4	102.6	.....	102.4	.....
1	101.2	101.3	.....	101.6	.....	102.8
6	101.8	102.0	.....	102.4	.....	.....
3	101.4	101.4	101.6	.....	101.7	.....
6	102.4	102.4	.....	102.6	.....	102.8
6	102.2	102.1	.....	102.4	102.4	102.5

* In all cases the respiratory rate mounted greatly, and before the experiment was finished, the rate had mounted from a normal of 20 to 25 per minute, to 250 to 300 per minute in almost every case.

Effects of Heat on Intestinal Activity

Since short wave diathermy is generally conceded to have no effects other than those produced by the generation of heat within the tissues, it seemed well to note the influence of various other types of heating on the activity of the intestines.

In 1899, Woodworth[5] made a study of the effects of heat on smooth muscle and reported that it reduces the tonus and diminishes the size, but increases the frequency of spontaneous contractions. Magnus,[6] in 1904, while working on the upper part of the intestinal tract, found that the average duration of a contraction was 3.3 seconds at 42 C., while at 29 C. the duration was ten seconds and at 16 C. it averaged forty seconds. He showed that the contraction would take place when the temperature of the muscle was raised to levels between 14 and 49 C. and rate and amplitude increased with rise in temperature up to 42 C., above which level a decrease (in rate and amplitude) appeared. In the rabbit, all movements cease at 47 C.

Taylor and Alvarez,[7] in 1917, declared that the increase per unit of temperature rise is greater in the lower portion of the bowel than in the upper and that the rate of rhythmic contraction is determined by the chemical changes taking place in the muscle. Ten years later, Weitz and Vollers[8] used hot enemas and hot water bottles on the abdomen and concluded that there was a decrease in the tonus. In 1933, Hepburn and others[9] made a study of temperatures in the intestine and found that diathermy (long wave) increased the temperature of the intestine only by 1 F. They did not obtain any uniform tendency to an increase or decrease of the temperature by application of hot wet packs, hot water bottles, electric pads or infra-red lamps. In 1935, Carlson and Orr[10] used moist heat applied to the abdomen of small dogs and produced a rise in temperature of 1.2 F., but once they observed a drop of 0.6 F. In patients on whom colostomy had been performed there was no change or drop in the temperature of the intestine following similar applications. Introduction of warm water into the intestine or application of an electric pad to the abdomen did not produce any tendency to increase or decrease the intestinal tone or amplitude.

Lüdin[11] was able to increase the intestinal temperature a maximum of 2.1 C. with long wave diathermy. He expressed the belief that local heating provokes a quickening and invigoration of the gastric peristalsis. De Couto-Silva[12] found that diathermy of sufficient intensity to produce an increase in temperature of the stomach to a maximum of 0.6 C. has no effect on gastric tone or contraction. In 1929, Stewart and Boldyreff[13] found that during "periods of rest" diathermy produces no change and the stomach remains at rest. During "periods of work" diathermy retards gastric contractions but does not suppress them altogether. However, the movements may become less pronounced and finally may stop altogether.

In the initial work on short wave diathermy, Mahlo[14] thought that at first there was an increase in peristalsis followed later on by a slackening. Neidhardt and Schlinke[15] expressed the opinion that not much can be drawn from the work of Mahlo, owing to the uncertainty of his conclusions. However, in a number of experiments which they themselves conducted, they were unable to draw any more definite conclusions from their own work. They stated that after five minutes of exposure, the tonus and peristalsis of the stomach subsided; tonus was decreased in four cases and remained unchanged in two, while peristalsis was decreased in five cases and unchanged in one. Their final conclusion was that with thirty minutes of diathermy there is no effect on tonus or peristalsis and that the results are not clear.

Rates of Contraction. — Alvarez[16] and others have made mention of the particular rates of contraction for various parts of the small intestine. High up, near the duodenum, the rate of contraction is appreciably faster than it is lower down near the cecum. This "theory of gradient," as it was first promulgated by Alvarez, stills holds true and has been proved by many observers. While our experiments were not designed to prove or add to the gradient theory, for the sake of completeness the segments of bowel exteriorized in the loops were chosen from various portions of the entire length of the intestinal tract. The majority of these loops, however, were taken from the distal end of the intestine generally measured from the cecum. Two loops were exteriorized high up in the tract.

As the loop of intestine is located higher up in the tract, the rate of motility increases (tables 2 and 3). This rate for the various segments of the bowel is

TABLE 2. — *Locations of the Various Loops Used in This Experiment.*

Animal	Location of Loop
1	15 cm. above the cecum
2	25 cm. above the cecum
3	30 cm. above the cecum
4	30 cm. above the cecum
5	30 cm. above the cecum
6	45 cm. above the cecum
7	80 to 100 cm. above the cecum
8	25 cm. below the ligament of Treitz

TABLE 3. — *Increase in Rate of Contractions After Short Wave Diathermy.*

Animal	Before Diathermy		After Diathermy	
	Contractions Per Minute	Readings	Contractions Per Minute	Readings
1	13.8	8	14.1	4
2	13.3	5	13.9	7
3*	9.3	3	9.5	3
4	13.4	12	14.4	17
5	12.19	11	13.22	14
6	12.24	45	12.57	58
7	16.9	17	18.3	18
8†	15.2	5	15.3	2

* Animal was ill during the entire experiment and finally died.
† Animal was very restless and unruly.

fairly constant. When measured in the same animal, there may be a difference of one or two contractions in three or four minutes when counted from day to day; but, over a period with a number of readings, a fairly constant rate will be found. In a few instances when the animal was well trained and well adapted for the work, it was used more often in preference to one which was restless and often unmanageable. In this way, a large number of studies was made on some animals and there is little variation in their rates.

Of all the types of intestinal motility present in the normal intestine, rhythmic segmentation and pendular movements are the most regular as regards the force and rate of contraction, although they are not necessarily the types most commonly found. In ordinary peristalsis, we often see a large, forceful contraction followed by a weak one occurring several times without any regular rhythm. Peristaltic contractions may be superimposed on one another, and in general are often unsatisfactory for a true evaluation of the rate of motility. Rhythmic segmenting movements are the most regular and the easiest to count and evaluate, and therefore have been used in computing any increase in the rate of peristalsis.

Observations were made to discover the effect of short wave diathermy on these rhythmic segmenting movements. No attempt was made accurately to evaluate the difference in strength of the contraction. These contractions, beginning weakly as they do, gaining in strength for a few minutes, and then subsiding, did not differ in character after the short wave diathermy was applied. However, table 3 shows the results produced on the number of rhythmic contractions per minute. Here will be found the first evidence of an effect of short wave diathermy on motility of the intestine.

A slight increase in the rate of contractions was found in all cases after the application of short wave diathermy (table 3). This is not to be taken to mean a corresponding increase in the strength of the contraction, but merely an augmentation of the number of contractions per minute over the number usually found for that animal. As far as could be determined, there is no increase in the strength of the contractions or other change in their character (figs. 2 and 3).

Some animals showed a greater increase in the peristaltic rate than others, the least being an increase of 0.2 contraction per minute, while the greatest average increase was 1.4 contractions. This represents a composite of all the records. Some records did not show as much increase in rate as others for the same animal, but at no time did we find any diminution in the number of contractions after short wave diathermy had been applied.

The question now arises, whether or not this increase in rate is due to some specific action of the short wave diathermy. Magnus and others showed that the application of heat to excised segments of intestine resulted in a similar increase in the rate of contractions. Our experiments seem to indicate that the results are due to the more thorough and penetrating heating action of the short wave diathermy. No results were discovered pointing to any other effects than those produced by heating. It has been demonstrated, however, that short wave diathermy does produce a slight, but very definite, increase in the rate of contraction of the intestine (fig. 4).

Roentgenologic Studies. — The colon was rendered opaque by the injection of equal volumes of water and thorium dioxide beneath the serosa of the transverse and descending colon. Preliminary roentgenoscopic studies were made to become acquainted with normal types of peristaltic movements. The colon was plainly visible and the slow, steady rhythm easily discernible. Contractions, when present, appeared to be at a rate of 10 to 12 a minute. No peristaltic rush movements were observed. Those seen generally consisted of slow, regular contractions. While one portion of the colon was contracted, another segment of several centimeters in length would be dilated. All motility seemed to stop at times,

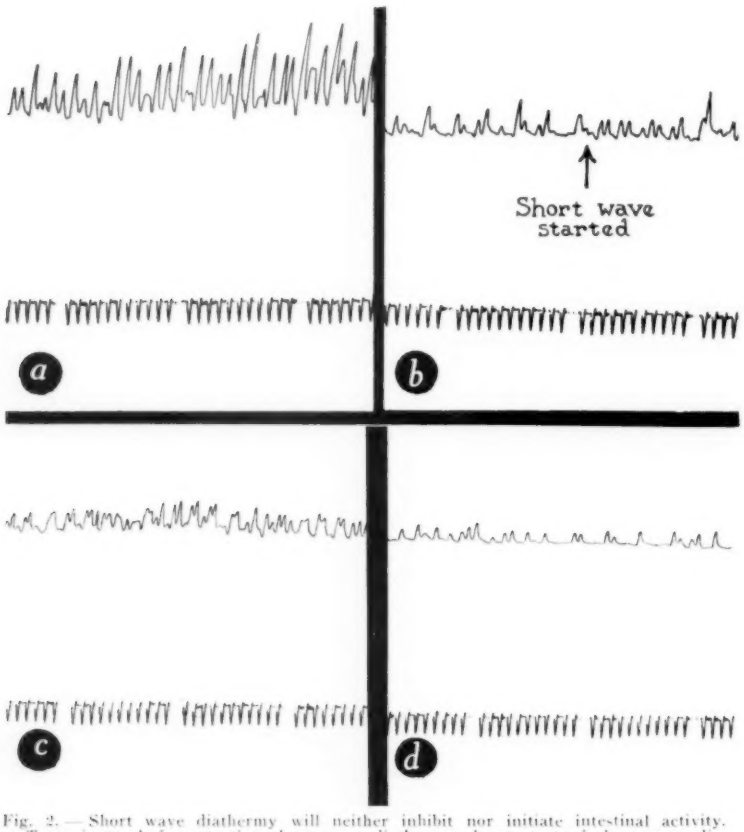

Fig. 2. — Short wave diathermy will neither inhibit nor initiate intestinal activity. *a*, Ten minutes before starting short wave diathermy; *b*, at start of short wave diathermy; *c*, after fifteen minutes of short wave diathermy; *d*, after thirty minutes of short wave diathermy.

and the bowel would appear to remain in a state of contraction or relaxation for a variable time. Various periods of fasting were tried and the results were much the same as have been observed in other parts of the intestinal tract. Intestinal movements would begin almost immediately after feeding, usually within three or four minutes. These consisted of slow, regular contractions.

The intestinal activity was observed every few minutes after the application of short wave diathermy for periods of twenty to forty minutes. This period was always sufficient to heat the animal so that it panted at a rapid rate, thus indicating that the short wave diathermy had produced heating. No immediate effect on intestinal activity from the application of the short wave diathermy was noted. Motility and tonus seemed to be about the same five minutes after the current was applied as they had been five minutes previous to the application. After twenty to thirty minutes, in four cases the motility appeared to have diminished. The upper end of the descending colon appeared to be at rest in a tonic state, while the lower portion seemed to be relaxed and slightly distended. In two of these cases the phenomenon occurred in the same animal, once after feeding and once after a twenty-four hour fast. However, this period of tranquility did not seem to differ in any way from the numerous quiescent periods observed before the short wave diathermy was applied. Moreover, the discontinuance of the short wave diathermy did not always result in continued activity even after the respirations had returned to normal and the animal was, to all outward appearances, free of the effects of the current. The cessation of movement observed in these cases seems to be coincidental.

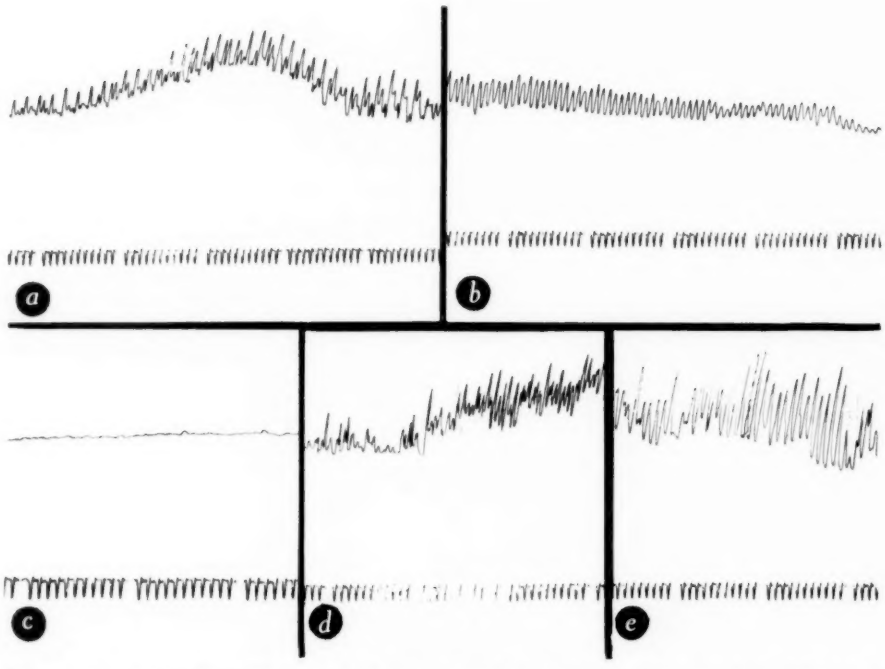

Fig. 3. — Continuation of figure 2. *a*, After forty minutes of short wave diathermy; *b*, after fifty minutes of short wave diathermy; *c*, after sixty minutes of short wave diathermy; *d*, after seventy minutes of short wave diathermy; *e*, after eighty minutes of short wave diathermy.

Lastly, after the short wave diathermy had been applied for thirty minutes and then discontinued, no effect on motility was noted. The colon remained in the same state as during the time the short wave diathermy was applied, either at rest or continuing the same rate and rhythm of regular contraction. Therefore, from visual observation of the injected colon of the dog by roentgenoscopy, it was concluded that any apparent increase or decrease in the motility observed after the application of short wave diathermy was purely coincidental.

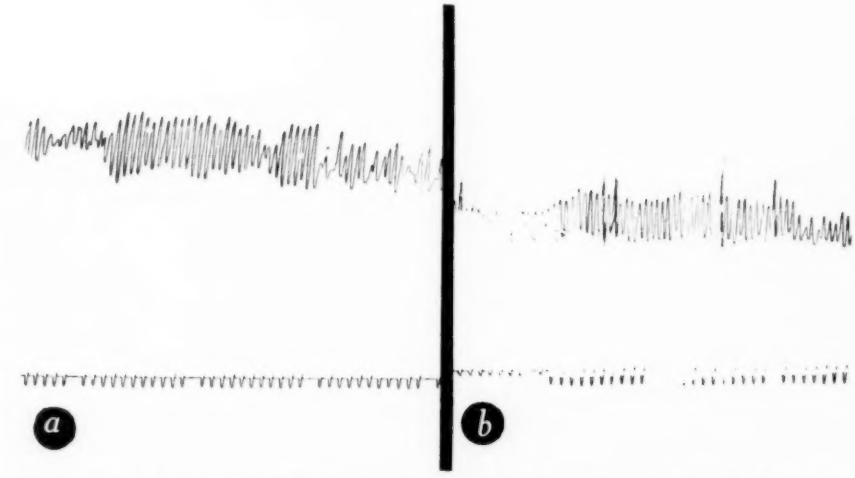

Fig. 4. — Rhythmic segmenting movements: *a*, before short wave diathermy, rate 16.5 per minute; *b*, after short wave diathermy, rate 19.5 per minute.

Summary

The problem undertaken has been an attempt to evaluate the action of short wave diathermy on intestinal activity. Exteriorized loops of intestine at various levels were prepared in a normal physiologic state.

Gross observations and kymographic records reveal that almost immediately after feeding there is an increase in the motility of the intestines. Fasting and dietary changes do not alter the rate of rhythmic contractions.

In the dog the most common types of movement found are the rhythmic segmenting and the pendular movements. These movements occur at intervals followed by periods of rest of variable duration. The time of one complete contraction of muscle varies with the temperature. At 42 C. the duration of contraction is 3.3 seconds, and if the temperature is dropped to 16 C., it takes forty seconds for a contraction. This process is reversible. Short wave diathermy, probably by producing a slight elevation of the intestinal temperature, causes a slight increase in the rate of contraction.

There is a definite gradient of rhythmicity in the intestine. On the application of short wave diathermy, a small amount of heat is produced, resulting in a slight increase in the rate of contraction per minute, although the gradient remains relatively the same.

Roentgenoscopic studies were not a satisfactory means of determining the effects of short wave diathermy on intestinal activity.

Conclusions

Gross observations of the exteriorized loop were not accurate enough to obtain a true evaluation of the effects of short wave diathermy on intestinal activity. Kymographic records showed that under the influence of short wave diathermy the intestinal tract of the dog did not undergo any changes other than those produced by heat, and that these changes were similar to effects produced by the direct application of heat to the intestinal walls. The amplitude or tonus of contractions did not seem to be increased to any appreciable extent, and their character was in no way changed. Short wave diathermy did not initiate contractions, did not increase the strength of contractions and did not diminish or stop the contractions of the intestine. The only effect demonstrable was a slight increase in the rate of rhythmic contractions such as is produced by the application of heat to the intestine itself.

Roentgenoscopic studies showed no visible changes in the character of the contractions while the animal was under the influence of short wave diathermy.

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EFFECT OF HYPERPYREXIA ON THE pH FIGURE OF THE BLOOD

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Prolonged application of high temperatures to the body may produce changes in its biochemical processes. Some years ago we[1] expressed an opinion of the probable manner of the action of hyperpyrexia. As regards its effects upon the pH figure of the blood and the carbon dioxide combining power of the plasma, our clinical observation has corroborated that of Hall and Wakefield.[2] In their studies of heat injuries and experimental heat-stroke there was a swing to the acid side. They found an increase of lactic acid, decrease of carbon dioxide combining power. The average increase of lactic acid was 96.2 per cent; carbon dioxide combining power decreased 30.3 and a decrease of serum pH of 0.19 per cent.

Since the advent of hyperpyrexia for therapy, Bischoff and his associates,[3] Hartman[4] and others speak of the presence of an alkalosis after such a seance. They believe that the hyperventilation, dehydration and lack of oxygen are the chief factors which bring on this condition.

Laboratory Investigation

To determine the comparative pH figures of the blood before and after hyperpyrexia we have made the following observations. They were made in the same manner on each patient before and immediately at the conclusion of each treatment.

The figures in the tables are not put forward as the actual pH of the circulating blood. They are comparative. The method of Voegtlin et al.,[5] gives accurate results. This technic requires the insertion of special glass electrodes into the vein. It was not considered feasible in our investigation.

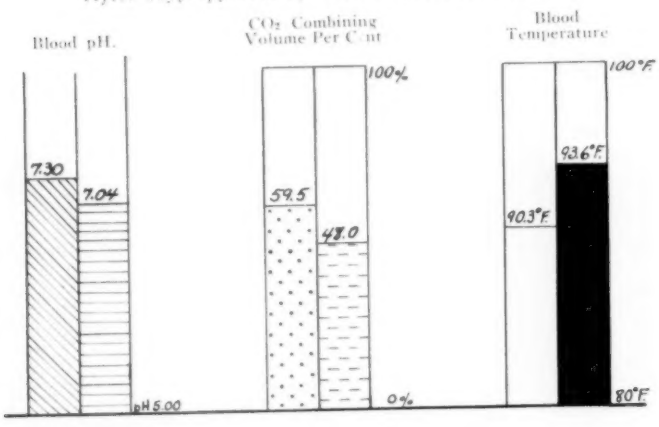
Our equipment was a glass electrode potentiometer. Before each use it was checked against standard solutions for accuracy.

The blood was drawn by a sterile syringe from the cubital veins. It was transferred into the cup of the potentiometer, which was placed alongside of the therapy chamber. A microthermometer of rapid acting type was used to make the temperature corrections; the pH figure was read. The time consumed from the transferance of the blood from the vein until the temperature correction and readings were completed averaged one and a half minutes. Quantities of blood drawn at the same time were sufficient for the carbon dioxide combining power examinations.

The data shown in the graphs of table 1 were obtained from seventy patients who were subjected to heat of 106.5 F. for seven hours.

The pH figure for the seventy patients gave a composite value of 7.3. This was lowered to 7.04 after seven hours of hyperpyrexia at a temperature of 106.5 F. The carbon dioxide combining power was lowered from 59.54 to 48.11. The blood temperatures measured in the potentiometer cup at the time of reading averaged 90.3 F. before treatment and 93.6 F. after treatment.

TABLE 1.—*Averages Obtained From 70 Patients Before and After Hyperpyrexia of 106.5 F. for Seven Hours.*



It is interesting to note the speed of the chemical changes in the blood which affect the pH figure. A series of readings was made at twenty second intervals for a period of four minutes. During this time there was a uniform rise in the pH figure of 0.2 to 0.4. This rise was common to each patient's blood both before and after treatment. This rate of change was the same before and after treatment.

In view of the Hall and Wakefield results as regards the high lactic acid content of the blood after experimental heat-stroke, we plan to investigate it as soon as we develop a method which is satisfactory for speed and accuracy.

Conclusions

1. The pH figure of the blood of seventy patients was studied before and after hyperpyrexia treatment.

2. There was a lowering of the pH figure and a reduction of the carbon dioxide combining power in each case.

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PHYSIOLOGIC BASIS OF HEAT *

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This paper is limited to three problems in the application of local heat, namely, relief of pain in abdominal conditions such as cholecystitis and spastic colitis; the treatment of traumatic edema of the feet, and finally the treatment of heat allergy. These conditions are selected to show some interesting case studies and research with regard to the physiologic basis for the use of heat.

Abdominal Pain

With regard to the first of these problems, heat to the abdomen has been successfully applied in our department for a number of years to relieve abdominal pain. The cause of the relief of this symptom has interested us for some time.

There is some conflict of opinion in the literature concerning the effects of heat applied to the abdomen. Among those who have found a rise in temperature within the abdomen after such application are Winternitz,[1] and Eichler and Schemel,[2] who induced with hot water bottles a rise of two degrees within the abdomen, while Stengel and Hopkins[3] found the results negligible. Hepburn and his associates[4] using hot water bags, hot wet packs, electric pads, infrared rays, and diathermy, were unable to increase the intragastric temperature after one hour or longer, except with diathermy. Orr and Carlson[5] in applying warm moist heat to the abdomen found a small rise in the temperature. This application of heat did not affect intestinal tone or movement. Their series of cases was small. Selden,[6] in a large series of experiments, found that heat, approximately at 50 C. applied for thirty minutes or more by a hot water bottle, raised the subjacent intraperitoneal cavity temperature 5.0 degrees C. in twelve guinea pigs and 6.0 degrees C. in six rabbits. When diathermy was applied through the diaphragmatic area the greatest increase of temperature was in the subdiaphragmatic regions. In the pelvis and rectum the change was very slight. Diathermy applied to the hind legs produced the major temperature rise in the pelvis and rectum. A rapid respiratory rate showed no influence in rabbits; in other animals the rise was reduced. The discontinuance of diathermy applied about the liver was followed by a slow but constant increase of temperature in the pelvis and rectum for twelve to twenty-five minutes. When diathermy applied to the hind legs was discontinued an increased temperature occurred in the pelvis and rectum and at times also in the subdiaphragmatic region.

A similar conflict in the literature concerns the effect on gastric secretion of heat applied locally to the abdomen. Brody[7] found that diathermy over the stomach region tends at first to increase both free and total gastric acidity followed by a depression of varying duration. De Couto-Silva,[8] treating dogs with the stomachs sandwiched between diathermy electrodes, secured a rise of one-half degree C. in the stomach but no effect on gastric secretion, tone, or contractions. Stewart and Boldyreff[9] found diathermy capable of increasing the secretion of gastric juice.

The effect of heat on blood and lymph flow from the gastrointestinal tract was studied by Beazell, Schmidt, and Ivy.[10] They applied heat to the lumina of isolated segments of the small intestine and the colon of dogs by means of an Elliott treatment regulator which resulted in temperatures ranging from 52.2 to 57.7 C. Under these circumstances the rate of blood flow through the treated

* Read at the Mid-Western Sectional Meeting of American Congress of Physical Therapy, Madison, Wisconsin, April 16, 1941.

tissue was markedly augmented, unless the mucosa was injured. In some experiments the rate of flow was doubled and in others quadrupled. This procedure had no measurable effect on the rate of flow of lacteal lymph. However, the secretion of the succus entericus was markedly augmented. When a temperature of 52.2 C. was applied to the lumen of the stomach there was no effect on the flow of lymph from the thoracic duct.

The possible importance of simple treatment often regarded as merely palliative has been shown by Bisgard and Nye[11] by recording gastrointestinal activity under varying conditions. Balloons were inserted into the stomach and small intestine by the esophageal route, and into the ileum and large intestine through stomata. Patients were selected who had normal alimentary movements. It is notorious that contraction or relaxation of smooth muscle may depend on its initial tonus which the balloons might have effected. Assuming that the recorded response coincides with what would happen without apparatus, we may accept the authors' conclusion that heat and cold applied externally to the abdomen do not affect the alimentary tract in the same way as hot and cold drinks. Hot packs inhibit, while hot drinks stimulate gastrointestinal movement. Conversely, ice packs stimulate and cold drinks have a slightly inhibitory action. Among the clinical applications of these findings the undesirability of applying cold externally to a person with a bleeding ulcer in the mistaken hope of inducing gastric quiescence is perhaps most significant. Cold applications greatly increase gastric acidity, an effect which the authors think may be due to the liberation of a histamine-like substance.

Animal experiments by other investigators suggest that the indirect temperature effect is reflex in nature. The physiologic aspect of the findings nevertheless needs elucidation. There is no difficulty in understanding the direct effects of heat and cold on contractile tissues, but the indirect effects are not so simple. Surface chilling is known to increase the tone of voluntary muscle and it might have the same effect on smooth muscle. However, this stimulus is known to cause the release of adrenalin, and this has an inhibitory action on all but the sphincters of the alimentary tract.

Kuntz[12] in a splendid article showing the relationship of the autonomic nervous system to physical therapy sheds some additional light on this subject. He states that gastrointestinal motility is inhibited by impulses reaching the enteric musculature through the sympathetic nerves and accelerated by impulses reaching the musculature through the parasympathetic nerves. He summarizes the present status of chemical mediators. A substance is liberated from the sympathetic called sympathin, and parasympathin is liberated by the parasympathetic system; the former causes vasoconstriction and the latter vasodilatation. The sympathetics also have vasodilator fibers to the gastrointestinal tract (Bulbring and Burns).[13]

The reactions carried out by the autonomic nerves are essentially reflex. By virtue of the reflex connections of afferent components of the cerebrospinal with the autonomic nerves, visceral functions may be influenced reflexly by diverse stimuli applied to the surface of the body or in the somatic tissues. The efficiency of physical therapy in the treatment of disease depends both on the reflex effect of the stimulating agents operating in part through the higher autonomic centers. The deep application of heat by short wave currents probably may result in deep stimulation of the autonomic nerve fibers or tissues in question, but reflex reactions due to this form of stimulation are not precluded since the changes effected in the tissues heated may give rise to stimuli which act upon receptors or the adjacent heated area.

It is important to recognize that there is a splanchnic peripheral blood volume ratio. Heat to the periphery of the body will cause a vasodilatation

of these vessels and a constriction of the splanchnics. This balance is in constant state of adjustment.

Pain following a produced ischemia is due to the release of a chemical substance which is acid and diffuses to pain endings. The application of heat produces a vasodilatation, the increased blood flow tends to wash out this substance and by so doing reduces its concentration and relieves pain. The local resistance of the tissues to infectious agents is increased by the more abundant blood supply, which accelerates the processes of reparation.

Kuntz also states that the principle of counterirritation, long recognized and applied, is based on cutaneo-visceral reflexes. In a fluoroscopic study of the effects on gastric tonus and motility of localized thermal stimulation of the skin, Freude and Ruhmann[11] (1926) observed that such stimulation in the epigastric area elicited gastric responses within a few seconds. Cold applications first inhibit gastric peristalsis, but after a short interval elicit irregular short peristaltic waves and retardation or cessation of the activity of the pyloric sphincter. Hot applications stimulate gastric peristalsis and elicit more frequent opening of the pylorus. They also inhibit preexisting hyperperistalsis. If the tonus of the gastric musculature is normal or subnormal, it is still further depressed by cold, and augmented by hot applications. On the contrary, if the gastric musculature is hypertonic, its tonicity is still further exaggerated by cold applications but inhibited by hot ones. In general, according to their findings, the effect of cold applications on the gastric musculature is similar to that of sympathetic stimulation, while hot applications result in a process similar to parasympathetic stimulation.

According to Boas[15] (1926) hot applications in the epigastric region presumably by increasing blood flow may provoke bleeding of a peptic ulcer, the existence of which had not been known. He recommends the use of hot applications in the epigastric area as a diagnostic measure in cases of suspected peptic ulcer. This, however, is a dangerous procedure and a hazard always to be looked for. In cases of peptic ulcer in which hot applications do not provoke bleeding, the hyperemia produced undoubtedly augments the healing process.

In summarizing, the alleviation of visceral pain by any stimulating agent applied to the skin which elicits localized peripheral vasodilatation probably depends mainly on the associated visceral hyperemia. Visceral pain, like somatic pain, not uncommonly is associated with ischemia of the organ or the tissues in question. The pain receptors involved are stimulated by a chemical substance which accumulates in the tissues because the circulation is insufficient to remove it. The functional activity of the vasomotor nerves, consequently, plays a major role both in the causation of visceral pain and in its alleviation. Functional imbalance of the autonomic nerves obviously may be an important etiologic factor in many lesions, both in the visceral organs and the somatic structures. Restoration of the autonomic balance, consequently, could be regarded as an important aim in the therapeutic treatment of such lesions. Therefore, we apply heat to those conditions such as cholecystitis and spastic colitis because heat here produces relaxation and increases the blood supply and thereby augments the healing processes.

Traumatic Edema

Another clinical problem is an attempt to find the best method of treating traumatic edema. Thus we frequently see swelling of the foot and leg to the knee following a simple injury such as a sprained ankle or a simple Pott's fracture. We have had a number of cases, one of which had been of a year's standing, and at Northwestern University there was one of three years' duration. Here, heat, massage, elevation and electrical stimulation were used in the treatment. McMaster[16] shows in his experiments that warmth definitely increases lymph

flow. He injected patent blue V into the skin of the volar surface of both arms of 8 normal individuals, subjecting one arm to the influence of heat while the other remained at room temperature.

During a 45 minute rest period prior to the test the subject sat with both forearms lying on the table. One arm was then gently submerged in a large cauldron, filled with water maintained at 46 to 47 C. while the control arm rested, in the same relative position, either upon the table, supported at the wrist and elbow by wooden blocks, or submerged in a large basin of water at room temperature. After immersion of 5 to 15 minutes, 0.02 to 0.03 cc. of dye mixture was injected into the volar surface of the control forearm about one-third the distance from the wrist to the elbow. As soon as possible thereafter, a similar injection was placed in the submerged arm while it was still under water. In a few instances the arm was lifted out, was injected and at once was resubmerged. In alternate tests the warmed arm was injected first. In all of them the arm remained just covered by the hot water where the effect of the injections could be observed through the binocular microscope and tracings made on celluloid. Photography was not attempted in these instances. In every subject hyperemia developed in the immersed arm. The lymphatic capillaries disclosed by injection seemed slightly wider than those in the control arm.

Drinker[17] states that when heat is applied there is a gradually increasing lymph formation which begins at 42 C. and not readily reversible changes begin to appear at about 50 C. He asserts that the lesson of such experiments is simple enough and that one can expect decided increases in tissue fluid with temperatures of 42 to 45 C. which is just about the limit of one's tolerance for heat. If it is of therapeutic advantage to increase both the vascular and extravascular circulation, then it becomes obvious that a part should be heated and at the same time massaged mechanically or moved passively.

It is important in the use of heat in this type of edema to make sure that there is no obstruction of the veins and lymphatics and that the temperature is not high. It has been shown by Bazett[18] that temperature changes have considerable effect on capillary pressure and consequently on the formation of tissue fluid. This fluid may ultimately leave the limb as lymph. Little is known at present as to the effect of an increased or decreased lymph flow on infective or other pathologic conditions, but at least partial control of this factor has potential usefulness and must receive some detailed consideration. The hypothesis has been advanced that the fluid interchange between the blood and the tissue fluids depends normally on a simple physical balance between the hydrostatic pressure of the blood in the capillaries (a pressure which tends to the filter fluid) and the osmotic pressure of the protein colloids which, unable themselves to pass the capillary wall, exert an attractive force on watery solutions of diffusible substances. The filtration head depends on the difference between these two forces and may be either positive or negative; fluid may therefore pass in either direction according to the conditions at the moment in any particular area of a capillary. This hypothesis has recently been supported by experimental evidence by Landis[19] who has demonstrated that the rate of fluid transfer is linearly proportional to this pressure difference.

Drury and Jones,[20] in 1927, showed that a rise of temperature considerably increased the rate of edema formation in the leg, when veins (and lymphatics) were partially obstructed by a moderate pressure. Widespread vascular changes throughout the body are associated with considerable readjustments in fluid balance. On exposure to warmth, transference of fluid from the blood to the tissues will be increased.

Heat Allergy

The final problem that is still under investigation in our department is heat allergy. A few patients are extremely sensitive to heat, so that exposure to

an infra-red generator will cause an intensive wheal formation or will make the patient feel faint.

The designation of "physical allergy" was applied by Duke[21] to the symptoms of bronchial asthma, vasomotor rhinitis, conjunctivitis, pruritis, urticaria, angioneurotic edema and others, caused specifically by the action of a physical agent such as heat.

Local urticaria which appears only on the area of skin exposed to heat is another type of heat sensitiveness. The mechanism by which localized heat urticaria is produced is unexplained. Duke states that with reference to heat and effort sensitiveness patients who are chronically highly sensitive to heat and effort have to reconcile themselves to a handicap and adjust their habits and occupations to degrees of heat and effort which they can tolerate. The immediate effect of heat and effort reactions can be very effectively relieved by cold and quiet. Frequently immersing the arms and hands in cold water is adequate. However, some individuals get reactions to cold as for example laundresses, housewives and photographers.

Hydrotherapy is very useful in the treatment of heat sensitiveness by desensitization. In highly sensitive subjects it is very difficult to apply heat without precipitating a reaction of some sort. Often a one-second exposure to a hot lamp will produce a reaction which may result in a total loss of consciousness or a convulsion, or result in twitching or violent asthma. For this reason heat has to be applied in the beginning of therapy with great care until the sensitivity of the patient is established. Frequently cold applied in a heat sensitive case will cause shivering and the heat generated by shivering may cause a reaction. For this reason both heat and cold have to be applied with equal caution. In the beginning of treatment it is frequently advisable to give bromides or adrenalin or both one-half hour before treatment is started. Heat may then be applied for a few seconds or possibly a minute or so until the patient begins to react. Reactions should be stopped immediately by applying cool cloths to the chest, arms and legs, or if the patient can stand it a rapid rub with ice on the chest, arms and legs. As soon as the reaction has ceased heat can be applied. This alternation of heat and cold can be continued at frequent intervals for a period of one-half hour and repeated daily and for a longer period of time as tolerance is gained. A high degree of tolerance for heat can often be induced within two weeks or two months.

Summary

1. There is a definite conflict of opinion with regard to rise in temperature and gastric secretion when hot water bottles, hot wet packs, e'ectric pads, infra-red rays and diathermy are applied over the abdomen in humans and experimental animals.

2. There was an increase in blood and lymph flow when heat was applied directly to the small intestine and colon in dogs, with temperatures between 52.2 and 57.7 C. but no increase in lymph flow when directly applied to the stomach.

3. Heat and cold when applied to the abdomen do not affect the alimentary tract in the same way as hot and cold drinks.

a. Hot packs inhibit while hot drinks stimulate alimentary movement.

b. Ice packs stimulate while cold drinks have a slightly inhibitory reaction.

c. Ice packs stimulate gastric acidity.

4. There are definite reflex relations between certain cutaneous areas and the gastrointestinal tract. Generally speaking internal organs are reflexly related to the skin directly overlying them. As a general rule the effect produced

by reflex is the same as seen in the cutaneous area treated. Cold applications to the cutaneous area produce a related effect upon the organ beneath, that is, a tonic or stimulating procedure. Applications of heat cause relaxations, increased blood supply and increased activity.

5. In view of the facility with which cutaneous stimulation elicits reflex visceral reactions, particularly vasomotor changes and changes in the tonic state of the visceral musculature, it must be apparent that many visceral disorders, particularly disorders of the gastrointestinal canal may be beneficially influenced by appropriate stimulation of the corresponding cutaneous areas. It is important to note in this connection that heat applied to the epigastric region will increase blood flow and provoke bleeding of a gastric ulcer if present.

6. Pain in an organ is due to a visceral ischemia which in turn is caused by a substance which accumulates and acts on the pain receptors. Heat applied in this case produces a reflex vasodilatation, decreases the concentration of this substance and thereby lessens the pain.

7. In treating cases of traumatic edema it is important to note that the heat applied should be mild and that the foot and leg should be properly elevated. One must make sure that there is no obstruction of the veins and lymphatics.

8. It is important to be on guard for heat allergy and to be sure that where such is suspected the patient is kept under careful observation. In patients with this type of allergy tolerance for heat should be gradually built up.

Conclusion

1. While knowledge concerning reaction to temperature applied to the body is growing there is obvious need for more controlled studies upon well and ill persons.

2. Knowledge of reactions has helped to rationalize procedures and clarified indications and contraindications.

3. There is a definite place for hot and cold applications and more experience will determine its extent.

4. A few examples illustrate how therapy can be rationalized.

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CELEBRATED FIGURES IN ELECTROTHERAPY *

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Electricity, the all pervading and perhaps the most powerful among Nature's array of physical phenomena created only a mild wonder when its manifestations were first observed. It took the work of many master minds in physical science as well as medicine to unravel its mysteries and to bring about sometime by a dramatic turn, new developments, which finally reached its present indispensable role in the home, industry, commerce, travel and in the art and science of medicine. Because of its spectacular nature electricity from its early days enabled charlatans of every description to exploit it for their nefarious ends. In the time at my disposal I shall pass in review some of the interesting figures of the past.

William Gilbert

It was Thales, the Greek philosopher, who first recorded the observation that amber, the fossil resin given up by the sea, when rubbed, had the mystic power to attract leaves and feathers and other light weight substances. Greek women wore amber beads in the belief that its mysterious soul would protect them against evil. The name of amber in Greek is *elektron,* the "shining thing." Another early observation of basic electrical manifestations was that of the loadstone or magnet, the peculiar kind of ore which came from Magnesia. It was noted that when a piece of it was suspended freely it always turned to the north. But centuries rolled by before these phenomena awakened scientific interest. In the sixteenth century the English physician William Gilbert, made the first successful effort to survey these barren facts in a scientific manner and by doing so became the father of electric and magnetic science. The very term electricity dates back to Gilbert's work.

William Gilbert was born in 1540, at Colchester, England, educated at Cambridge University and received his degree of Doctor of Medicine at the age of twenty-nine. On leaving Cambridge he traveled for four years on the Continent, visiting medical schools and studying methods of treatment. Returning to London in 1573, he began to practice medicine apparently with great success, for in 1599, he was elected president of the Royal College of Physicians and in 1601, was appointed physician to Queen Elizabeth with an emolument of 100 pounds a year (fig. 1).

While Sir Francis Bacon, Queen Elizabeth's Chancellor, was proposing the inductive method of studying Nature, Gilbert deplored the ignorance of the men of his day with respect to natural things and challenged them to "quit the sort of learning that comes only from books and that rests only on vain arguments." "Even men of acute intelligence," he pointed out, "without actual knowledge of facts and in the absence of experiment easily fall into error." He equipped himself with steel needles, iron bars, globes, magnets, diverse minerals, pieces of amber and precious gems in order to pioneer in a strictly experimental method of investigation. He was always willing that those who felt so disposed should challenge his findings and repeat his experiments.

The full account of Gilbert's experiments on magnetic bodies and on electrical attraction was published in 1600, in the volume entitled "De

* Read before the Section of Historical and Cultural Medicine of the New York Academy of Medicine, New York, January 8, 1941.

Fig. 1. — William Gilbert (from Potamian and Walsh).

Magnete," a masterpiece of strictly investigative work and of original matter. He applied the term "electrick" to substances like resin, sulphur and sealing wax which could attract very small weights as could amber (*elecktron*), and distinguished them from "metals, marbles, flints, woods, herbs, flesh and many other things that can neither allure nor solicit any body magnetically." He also noted that "the difference between magneticks and electricks is that all magneticks run together with mutual forces; electricks only allure."

Gilbert was the first to advance the conception that the earth is nothing but a large magnet, thus explaining not only the direction of the magnetic needle north and south but also the variations and inclinations of the needle. He was the first to use the term "magnetic poles." Gilbert next asked, "If the earth has a magnetic field, why not the moon, the planets and the sun itself?" and concluded that the daily rotation of the earth on its axis is but part of a prevailing system of magnetic forces.

The merit of "De Magnete" was instantly recognized throughout England and Europe. It brought Gilbert great fame. Thomas Fuller in his "Worthies of England" prophesied, "Mahomet's tomb at Mecca is said strangely to hang up, attracted by some invisible lodestone; but the memory of this doctor will never fall to the ground, which his incomparable book De Magnete will support to eternity." The great poet Dryden wrote:

> Gilbert shall live till loadstones cease to draw
> Or British fleets the boundless ocean awe.

As chief physician to Queen Elizabeth, Gilbert was probably one of the group of "ten or twelve physicians that were continually about her" when, overcome with remorse over the execution of the Earl of Essex, she developed mental symptoms, and lay upon cushions on the floor for four days. Despite her physicians' entreaties, she refused all food and medicine, and finally succumbed.

Gilbert was appointed physician to Elizabeth's successor, James I, but eight months later was stricken by the plague. He died December 10, 1603, in his sixty-fourth year, and was buried in Holy Trinity Church, Colchester. On

the three hundredth anniversary of his death, a painting of Gilbert exhibiting his electrical and magnetic experiments to Queen Elizabeth and her court (which included Sir Walter Raleigh, Sir Francis Drake and Cecil Lord Burghley), was presented to the Corporation of Colchester by the Institution of Electrical Engineers, and is now on exhibition in the Colchester Town Hall.

Gilbert's observations resulted in widespread interest and further experimentation with electrical phenomena. Because the amount of electricity produced by the early method of rubbing glass or sealing wax rods with silk produced only small quantities, various types of frictional electrical apparatus were invented. With the discovery of the Leyden jar, larger amounts of electricity could be stored, and gradually the precursors of the large static apparatus appeared. Frictional electricity was employed in the form of electric sparks and electric "baths" and there was much speculation as to its therapeutic effects. The first physician on record to insist on a rational indication and definite dosage of electric treatment was the French revolutionary Marat, who is one of the most extraordinary figures in the history of electrotherapy.

Jean Paul Marat

Jean Paul Marat was born in 1743, in the Swiss canton of Neuchatel. In one of his publications, "Le Journal de la République française," he left us a remarkable account of his youth, in which he says that he was born with an impressionable nature, a fiery imagination, a heart open to every lofty passion and, above all, the love of Fame which devoured his mind. Marat also declares that his moral sense was already developed at the age of 8, for even then he could not bear to see ill-treatment practiced upon another, that "the sight of cruelty filled him with indignation," and that "injustice made his blood boil like a personal outrage."

At the age of 18, Marat left the paternal roof and went to study medicine in Toulouse and Bordeaux, after which, for fourteen years, he seems to have divided his time between England, Scotland, Ireland, Holland and Paris, where he settled for a time in 1751. About the year 1765 he again returned to London, when he commenced practice as a doctor in Church Street, Soho, and remained for ten or twelve years, during which time he seems to have been a welcome guest in the best literary, scientific and artistic circles. While in London he wrote a paper, "An Enquiry into the Nature, Cause and Cure of a Singular Disease of the Eye." Returning to France he became physician to the bodyguard of the Comte d'Artois and was soon in great demand as a court physician among the aristocracy (fig. 2).

Up to the time of the Revolution in which he was to play such a conspicuous role, he was occupied with philosophical and medical work, especially the study of light, heat and electricity. Shortly after his return to France he took part in a disputation, held by the Academy of Lyons, on the value of electricity in medicine. This disputation appears to have been rather acrimonious. Abbé Bertholon, in his paper entitled "The Influence of the Electricity of the Atmosphere on Diseases," made extravagant claims for the use of electricity in its only form known at that period, frictional or static electricity. The abbé contended that all diseases were due either to a deficiency or an excess of the electric fluid; the former cases he treated by the electric bath, the latter by drawing off the excess from the back of the hand of the electrically charged patient. Marat would have nothing to do with such sweeping claims, based on pure empiricism; he demanded that it be shown definitely in what diseases electricity should be used, and that its mode of action be determined.

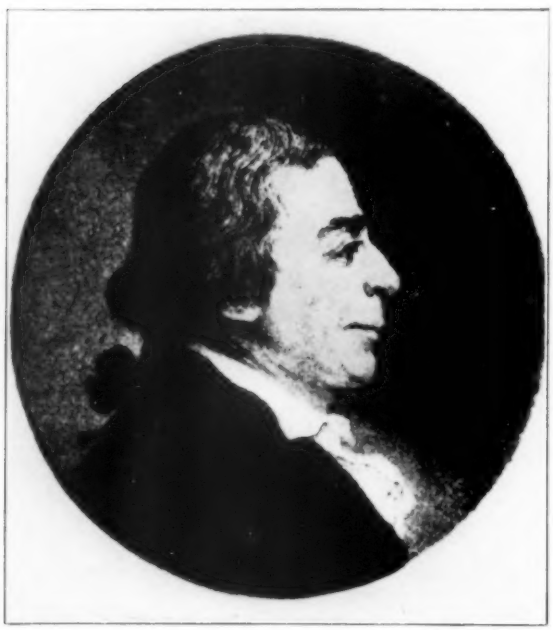

Fig. 2. — Marat, the scientist (from Cabanes).

Bringing his investigations to a conclusion, Marat published in 1784, a book on electrotherapy, "Memoires sur l'électricité médicale" in which he states, "One will not find in this publication any hypothesis, any uncertain experiment, any doubtful principle, any hazardous conclusion; it is upon facts alone, but upon simple and constant facts that all my reasoning is based." Marat rejects the idea that the atmospheric electricity has any effect upon the human economy and states that from the electric bath he only obtained moderate results. He studied the effects of sparks and shocks, applied in accordance with the practice of his time. Conducting experiments on animals he concluded that of the fluids of the human body the urine was the best electrical conductor; next in order came bile, blood, lymph, and the synovial fluid. Marat held that electricity was justified in the treatment of external indolent tumors, edematous engorgement of the limbs, cutaneous eruptions, paralysis, hemiplegia, rheumatism, sciatica and the colic of painters, founders and enamelers. He insisted that the duration of a treatment should be definitely fixed, that there should be a dosage of electricity as well as of other medicines.

Marat's first political work was entitled "The Chains of Slavery," and was written and published in London, in 1774. In it his revolutionary ideas of social reform began to show themselves very clearly. It would appear that he had two personalities: One, that of a scientist and philosopher, which died in 1789, the year of the fall of the Bastille, the other, that of a fanatical journalist, pamphleteer and demagogue.

Throughout his life he had always endeavored to attract public attention, and when opposed by others became morbidly introspective. In his later years he was despised and jeered at in academic circles and believed himself persecuted and libeled by everyone. Cabanes declares that Marat was hypochrondriacal and exaggerated greatly his own infirmities and that he poured out his bile in pamphlets and his bad temper in sentences of death. Cabanes suggests that it was the bodily infirmities that warped Marat's frame of mind

and that the perpetual irritation and itching of pruritus from which he suffered caused his temperament to become sanguinary and ferocious. Marat suffered from insomnia and constant headaches; that is why he is often represented with a cloth on his head, the cloth being soaked in vinegar. Cabanes believes that Marat's skin affection was of the nature of eczema, affecting largely his scrotum and perineum, and that the exacerbations of his pruritus coincided with the violence of his phrases in "L'Ami du Peuple" and the other revolutionary journals to which he was the chief contributor. The only way by which Marat could get relief from his pruritus was by constantly sitting in the well-known shoe-shaped bath, which was made of beaten copper, and across which a board was put on which Marat used to write his various articles. The curious shape of the bath seems to have arisen from the necessity of economizing water owing to the difficulty and expense of carrying it upstairs and from a distance.

As is well known, it was while he was sitting in this bath that Charlotte Corday stabbed him in the chest on July 13, 1793. Charlotte Corday, who was guillotined for this crime, is said to have died saying: "One man have I slain to save a hundred thousand."

During the early days of its introduction, electricity, especially the imposing frictional apparatus with its mysterious force, became a ready tool for mountebanks and borderline practitioners to claim marvelous cures and perpetrate all kinds of humbugs. It may not be without interest briefly to mention two notorious figures of those times.

James Graham

The first celebrated electrical quack on record was James Graham, who lived in England between 1745 and 1794. His career was of surpassing brilliance. He obtained some medical training and wrote M.D. after his name and claimed to be a graduate of Edinburgh University, although according to Colwell that university modestly disclaimed any pretension to be his alma mater. He traveled in America and may have acquired some electrical knowledge from the study of Benjamin Franklin's work. On his return to England, Graham practiced electrical treatment at Bath, Bristol and in 1779, at Aix-la-Chapelle where he treated Georgina, the Duchess of Devonshire. With her patronage, he established himself in a fine house in London. This came to be known as the Temple of Health. Here he lectured and sold such nostrums as an electric ether, an elixir of life and some "imperial pills." He published glowing advertisements in the best modern manner. He signed himself "President of the Council of Health," delivered lectures and promised immediate pregnancy to the barren by the use of his grand "Celestial Bed." By means of this most extraordinary piece of furniture — one of the frictional electric machines of the period — Graham claimed "children of the most perfect beauty could be begotten." A fee of fifty guineas a night was charged for those who wished to occupy this magical bed and there seemed to be plenty takers.

Graham described his Celestial or Magnet-Electric Bed as the "first and only one that ever was in the world." "It is placed in a spacious room to the right of my orchestra, which produces the Celestial fire and vivifying influence; this brilliant Celestial Bed is supported by six massive brass pillars with Saxon blue and purple satin, perfumed with Arabian spices in the style of those in the Seraglio of the Grand Turk. Any gentleman and his lady desirous of progeny, and wishing to spend an evening in this Celestial apartment, may by a compliment of a fifty pound bank note be permitted to partake of the heavenly joys it affords by causing immediate conception, accompanied by the soft music; the superior ecstasy which the parties enjoy in the

Celestial Bed is really astonishing and never before thought of in this world." On special occasions an ode set to music was performed by a "selected choir" accompanied by the organ and a band of instrumentalists." Graham included even breakfast in his services.

In the evenings Graham mounted a Magnetic Throne and lectured, demonstrating his medico-electrical apparatus. He charged a guinea for his first consultation and five shillings and half a crown for admission to his lectures. His Temple became the vogue for a time and was daily crowded with fashionable curiosity seekers. It is said that Amy Lyon — better known afterwards as the celebrated Lady Hamilton, companion of Lord Nelson — officiated in the Temple as a Goddess of Beauty in the nude. The place was so successful that a few years later Graham took over Schomberg House in Pall Mall, fitted it up lavishly, and called it the Temple of Health and of Hymen. Here he installed a Celestial State Bed of greater magnificence than his previous apparatus. But interest began to die out. In spite of his flood of flamboyant advertisements, bills and pamphlets, the new establishment did not prove a success and as creditors began to press for payment, it had to be closed.

Leaving London, Graham went off to other pastures, lecturing and consulting in Liverpool, Newcastle and Edinburgh. In the last place he offended the authorities, was arrested and thrown into prison from which he was released after paying a fine. Next he sought to found a new religion and issued a pamphlet entitled "Proposals for the Establishment of a New and True Christian Church." But this met with scant support and California was not available yet at that time as the haven of new fangled beliefs. It is reported that later "Graham was half mad and his madness at last got the better of his knavery. He would madden himself with ether, run the streets and strip himself to clothe the first beggar he met." Thoroughly disgraced, he died suddenly at the early age of 49, thus making this a moral tale.

Elisha Perkins

The doubtful honor of having "invented" and successfully exploited the first quack electrical appliance on a large scale belongs to an American, Elisha Perkins, originally a student of Yale, and a medical practitioner in Norwich, Connecticut. He conceived about 1796, the idea that metals when applied externally to the body "would draw disease from it." According to his own account, one rod was composed of copper, zinc and gold, while the other was of iron mixed with silver and platinum. They were probably made of iron and brass, rounded at one end and pointed on the other. Perkins claimed that by the use of his "tractors" the body could be freed from disease without any other treatment. When applied, it was necessary that they should always be drawn downwards; also, that in obstinate cases friction was to be used until the skin flushed red. Finding the local medical society skeptical of his claims for the virtues of his tractors, Perkins left Norwich for Philadelphia where he was received with enthusiasm at the various hospitals and infirmaries he visited to demonstrate his appliance. The members of the Congress then in session were greatly impressed by his story, and George Washington himself purchased a pair of the tractors for his family. Perkins patented the tractors and they had a very large sale throughout the United States. They cost him about sixpence, but he managed to sell them at five guineas a pair (fig. 3).

Setting the example for overseas extension of many other electric fakes to follow, Perkins sent his son, Benjamin Douglas, to England to introduce them to the Britishers. Benjamin succeeded in doing so, and within a short

Fig. 3. — Caricature of Perkins' Tractors (from Colwell).

time hundreds of clergymen, including the chaplain to the Prince of Wales, Lord Henniker, and other influential personages, testified to their wonderful power. A "Perkins Institute and Dispensary" was established for the poor, with Lord Rivers as president, and the Royal Society accepted a pair of the famous appliances and a copy of Perkins' book.

Caricaturists seized on the prevailing craze of using the "tractors" for all kinds of ailments, and poets and ballad singers sang their praises. A popular song said:

> "Arm'd with twin skewers see Perkins by main force
> Drag the foul field from Christian and from horse."

Even the great poet Byron immortalized them in the following lines:

> "What varied wonders tempt us as they pass,
> The Cow-pox, Tractors, Galvanism, Gas,
> In turns appear to make the vulgar state
> Till the swoll'n bubble burst — and all is air."
>
> — England Bards and Scotch Reviewers.

The fraud of Perkins' contraption was finally exposed by a medical practitioner of Bath, Dr. John Haygarth. He shaped a pair of tractors out of two pieces of wood and painted them to appear like the metal appliances. With these he produced even greater cures than the originals; then, together with another medical friend, he sent these wooden imitations to other physicians, and they forthwith reported astonishing results. The bubble of the tractors was thus burst. Perkins Junior packed up his trunks and returned to the United States, but the rich harvest of some 50,000 dollars which he reaped in London went along with him.

Luigi Galvani

Turning now from quackery to science, the modern epoch of electrotherapy and as a matter of fact of electricity itself started with the observations of Luigi Galvani, professor of anatomy at the University of Bologna. Born in 1737, and entering an academic career, Galvani made many painstaking studies of comparative anatomy, especially of birds. In his experimental work he observed the effects of electricity on animals. When one day in 1786, an electrical machine was turned on in his laboratory and the leg of a skinned frog was accidentally touched by a scalpel, the leg suddenly twitched. This accidental observation led to one of the great discoveries of all time, for it originated in Galvani's mind the idea of animal electricity and developed into the basic method of generating an electrical current by

Fig. 1. — Luigi Galvani (Portrait in the Library of the Bologna University, from J. de radiol. et d'électrol).

chemical means. Galvani went on to prove that atmospheric electricity as manifested in lightning would produce the same effects on muscular movements. He dared to place an atmospheric conductor to the highest point of his house and from this he ran down a wire to his laboratory and attached it to a prepared frog leg and behold, whenever lightning flashed from the clouds, the limbs of the animal underwent violent contractions. He thus corroborated Franklin's observations that the effects of electricity from a frictional machine and from lightning were identical. Galvani's explanation of the twitchings was that a metallic arc was formed by the union of the exterior or negative charge with positive electricity which proceeded along the nerve from its inner substance. He felt much reaffirmed in this view by another interesting observation. When skinned frogs were suspended from a copper hook on the iron railing of his balcony, whenever the wind blew the legs would violently twitch (fig. 4).

After five years of continued work, Galvani brought forth an epoch-making work "De Viribus Electricitatis In Motu Muscularis Commentarius" — (Commentary on the Forces of Electricity in Relation to Muscular Contraction). It consisted of four parts in sixty-four pages, written in classic Latin, and reported with scientific accuracy his experiments and conclusions. In the first part, Galvani described his experiments with the then known sources of electricity, chiefly the electric machine and the Leyden jar in bringing about muscular contractions. The second part deals with such effects by atmospheric electricity — chiefly lightning. The third part discusses the effect of animal electricity on muscular contractions, and contains Galvani's conclusions on the existence of animal electricity. The last part prophetically suggests the use of electricity for the cure of certain nervous disorders, es-

pecially paralysis, also that living beings, plants and animals may be influenced in their growth by electrical charges from the clouds and from the earth itself. Galvani surmises that changes in atmospheric electricity may be responsible for the curious feelings manifested in men and some animals before an earthquake.

It is but natural that not all the views expressed by Galvani should have been accepted by his contemporaries. As to his very conception of animal electricity, his contemporary, Alessandro Volta, proved that the twitching of frog's legs was caused by an electrical flow started between two dissimilar metals. Some other scientists doubted that any of his painstaking observations would lead to practical results, and one man even went so far as to nickname him "the frog dancing master." Galvani, however, went on indefatigably with his work until there came a tragic turn in his career. His patriotism placed him in opposition to a new aristocratic regime in his native city. A so-called Cis-Alpine Republic of Italy was established under French influence by force of arms and all professors of the university were requested to take an oath of allegiance. Galvani, feeling that the new regime was an usurpation of the rights of the people, refused to do so and as a consequence lost his position and salary. Deprived of his means of livelihood, he fell into a feverish decline and although in consideration of his scientific fame, the new government finally restored him to his professorship, this came too late and he passed away on December 4, 1798.

At the two hundredth anniversary of Galvani's birth in 1937, a national celebration was held at the University of Bologna. Three scientific congresses assembled and in the same lecture room where Galvani used to teach, his classic frog experiment was repeated in the presence of the King of Italy and a body of distinguished scientists from all parts of the world, including Nobel prize winners. In some of the papers presented it was emphasized that Galvani's genius was right when he spoke of animal electricity, for it is now an established fact that each living manifestation in the human body is accompanied by demonstrable electrical changes. Galvani's name lives on in the term of galvanism or galvanic current and in the galvanometer, the principal instrument of electrical measurement. Galvani's original observation marks the beginning of a whole series of epoch making discoveries in electricity. Among these are Oersted's discovery of the effect of the direct current on the magnetic needle, Faraday's discovery of electro-magnetic induction, Maxwell's electromagnetic theory and finally Hertz's discovery of radiating electromagnetic energy into space. Thus the development of present day electrical science is inseparably linked up with the path-finding work of the two physicians, Gilbert and Galvani.

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EVALUATION OF PHYSICAL THERAPY IN PERIPHERAL VASCULAR DISEASE *

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PHILADELPHIA

Physical therapy is constantly becoming of increasing importance and has contributed much to the management of peripheral vascular disease. Many of its measures date back a number of years while some are comparatively recent. The latter come under the head of mechanotherapy and consist of (1) intermittent venous occlusion and compression; (2) passive vascular exercises by suction and pressure; (3) Sander's oscillating bed; (4) intermittent arterial occlusion; (5) x-ray therapy to the sympathetic ganglia.

Other methods which have been used for many years consist of (1) heat and thermal changes; (2) Buerger's exercises; (3) rest; (4) iontophoresis with mecholyl.

The development of collateral circulation by direct mechanical action has brought forward several types of machines which vary greatly in their action.

Mechanical Methods

Treatment by intermittent venous compression was first proposed by Coleas and Wilensky[1] and based on the work of Lewis and Grant.[2] It consists of a blood pressure cuff, placed around the extremities to be treated, above the knee or the elbow. Intermittent pressure is applied by an electric motor pump which restricts the venous return and not the arterial inflow. The pressure is usually about 60 mm. of mercury below the systolic blood pressure. It is applied for two minutes and then released for two minutes. The time of treatment varies with the amount of involvement. This treatment is based on the observation that hyperemia follows release of compression; that there is a stretching of the vessels with permanent dilatation, giving more space for circulating blood. Although we have had many excellent results from this treatment, reports of value differ greatly. Collens, Wilensky and Ginsberg[3] report the healing of 71 per cent of patients having gangrene and ulceration due to thromboangiitis obliterans and relief of pain in 85 per cent. Allen[4] and his co-workers report a much lower percentage of cures and relief of symptoms. This machine has the advantage that it is portable, can be operated by the patient, and is less expensive than some of the other apparatus.

Passive Vascular Exercise by Suction and Pressure. — This comparatively modern apparatus is based on the theory of lowering the environmental pressure and resistance of the parts in order that more blood will flow through the affected areas of the vascular system and dilate the collateral arterial pathways. For this, we are indebted to the work of Landis and Gibben[5] and Reid and Herrmann,[6] in 1933. The involved extremity is confined in a strongly made boot with a transparent covering, and by means of an electrically propelled pump alternating cycles of suction and pressure are maintained. In our clinic, we have found that two cycles per minute with a pressure of 20 mm. of mercury for five seconds and a suction of 80 mm. of mercury for twenty-five seconds has given the best results. The length and number of treatments vary with the condition of the patient and amount of vascular occlusion.

* From the Department of Physical Therapy, Jefferson Medical College Hospital.
*Read before the Pennsylvania Physical Therapy Association, Philadelphia, April 10, 1941.

In 1937, I[7] reported a series of fifty cases treated by suction and pressure at the Curtis Clinic, Jefferson Hospital, which had been observed over a period of one year and, at that time, noted that our best results were obtained in diabetics who showed evidence of vascular changes with impairment of the peripheral blood supply. In this series, five cases of Buerger's disease were treated, three of which were completely relieved or rendered symptom-free. Also, there was noted healing in trophic ulcerations with a marked relief of pain in chronic occlusive arterial disease.

In our present series of one-hundred and fifty properly selected cases, the best results have been obtained in diabetic arteriosclerotic lesions, acute embolism and frost-bite. Ten cases of thromboangiitis obliterans were symptom free. Marked relief of pain was noted in 40 per cent of patients suffering from arteriosclerosis obliterans. In three cases of trophic ulceration it was necessary to lower the amount of suction and pressure due to the fact that there was bleeding from the ulcerated areas and increased pain. Two patients with traumatic occlusion of the brachial artery responded well, while one with Raynaud's disease was unimproved and the symptoms actually were aggravated.

Sindoni[8] reports that some patients with ulcerations have been aggravated by suction and pressure, but in these with occlusions, especially of the iliac vessels, there has been a marked diminution of pain and that this is the only method by which this type of occlusion can be treated. He also states that in every one thousand admissions to this clinic, one out of six have had one or both legs amputated as a result of diabetic gangrene.

Reports from other workers have been variable. Veal[9] treated seventy-four cases of obliterative vascular disease, thirty-eight of which were relieved or improved. Allen and Brown[10] consider this type of treatment of less clinical value. This method has the disadvantage of requiring a bulky and less portable apparatus; the time of treatment is long, so that several machines with boots are necessary if more than a few patients are to be treated in one day.

The contraindications are: (1) in thrombophlebitis; (2) extensive moist gangrene; (3) celluitis; (4) in any cases manifesting intensification of pain.

Sander's Oscillating Bed. — An oscillating apparatus representing a mechanized treatment described by Sanders[11] is now very commonly used. The head and feet of the patient are alternately elevated and lowered by means of this oscillating bed, during a cycle which takes from one to three minutes. The principle involved is that of passive postural exercises which allow intermittent filling and emptying of the capillaries, venules and probably arterioles. Frequently a thermostatically controlled cradle which is heated to 96 F. is an adjunct to treatment. Stroud[12] reports very favorable results in one hundred cases, espécially in trophic ulceration, advanced arteriosclerosis and impending gangrene. Barker and Roth[13] had excellent results in a series of eighty-eight cases of chronic occlusive arterial disease. Patients are kept on this bed for at least one month. Although excellent results have been reported by this type of treatment, the chief objection is that these beds are very expensive and unless a number are available, very few patients can receive the benefit of this therapy.

Intermittent Arterial Occlusion. — In this type of treatment the arteries of the involved extremity are compressed by an ordinary sphygmomanometer cuff. The pressure in the cuff is maintained above the systolic blood pressure for five to fifteen minute periods and then rapidly deflated from ten to fifteen minute periods. This procedure was described by Thiele[14] who reported relief of pain and restoration of circulation in several cases. So little work has

been done with this type of treatment that authoritative information can not be given at this time.

Roentgenotherapy to the Sympathetic Ganglia

Roentgen irradiation of the posterior thoracic and lumbar areas was first advocated by Phillips and Tunic,[15] in 1925. They found that patients were relieved of pain. The effect, however, was not immediate as a rule. They also reported an improvement and subsiding of claudication in 50 per cent of their cases. Since then, numerous other workers have observed that there was in some instances definite clinical improvement as shown by the increased warmth in the extremities and the tendency for ulcers to heal. The best results were obtained in cases of vasospasm. This improvement is probably due to the production of vasodilatation of the peripheral vessels, presumably ascribable to the effects of irradiation on the sympathetic ganglia. Moderate doses of 50 to 100 R units through a filtration of ¼ mm. of copper and 1 mm. of aluminum with large portals, are given at weekly intervals.

Heat and Its Effects

Heat in all forms is an invaluable aid in the treatment of vascular diseases. Heat cradles thermostatically controlled keep the skin temperature at 92 to 96 F., stimulating normal metabolic processes. This is probably one of the oldest and most commonly used methods of physical therapy. Diathermy of the short wave type is effective in producing peripheral vascular dilatation. Some workers have found it best to apply the electrodes to the trunk or abdominal areas rather than to the extremities as numerous burns have been reported in treating poorly vascularized parts. It is a common fact that patients suffering from passive vascular diseases, especially diabetics, do not have normal sensations to pain in their extremities and great care must be exercised in treating them in order to avoid these slow healing burns which become so easily infected. Many cases of gangrene and trophic ulceration have resulted from this unfortunate occurrence. In our department, short wave diathermy has proved extremely satisfactory as an adjunct in the treatment of peripheral arterial diseases. We apply one electrode to the buttocks and the other, well spaced by padding, to the feet. There can be no doubt of the effect of this form of treatment in peripheral arterial diseases as shown by improved nail growth, increased warmth in the extremities, decrease in pain and ability to walk further.

Buerger's Postural Exercises. — Exercise has a definite place in the management of peripheral arterial diseases. The patient is instructed to lie flat on the back and elevate both legs to an angle of forty-five degrees for two minutes. The patient now changes his position to sitting on the side of the bed with the feet pendant for three minutes. The next position is recumbency. This session of four to five cycles should be repeated from two to four times daily.

Iontophoresis with Mecholyl.—J. Kovács[16] has demonstrated that iontophoresis with mecholyl in a quarter of one per cent solution, given two or three times a week, has caused increased warmth of the extremities and improved collateral circulation of the hands and feet especially in Raynaud's disease. A galvanic machine is used with a smooth current, gauze saturated with this solution of mecholyl is placed under the positive pole and applied to the affected area. The negative electrode is placed elsewhere on the body. Fifteen to twenty milliamperes of current is used and applied for thirty to forty minutes. The drug is absorbed through the skin and increases the local circulation, as shown by an erythematous flush and a feeling of warmth and fullness. There is a sensation of comfort and marked diminution of pain and

fatigue. This may last for twenty-four hours or even for several days. Treatment should be given every other day, during the series, until ten or twelve have been completed, and then twice weekly. Later, treatments may be continued once a week.

Diagnostic Considerations

Passive vascular disease signifies simply a disturbance or arterial diminution of the normal amount of circulating blood to the part and patients suspected of having this condition should not be treated by any of the methods described unless the condition is definitely proved. The necessity for a careful physical examination including Wassermann and other blood studies, is expedient, as wide varieties of conditions simulate passive vascular diseases. Pain arising from orthopedic conditions such as flat feet or bone and joint changes, very frequently simulate peripheral vascular diseases, and the findings and opinions of the orthopedic department are essential. The skin and nails should be checked for color and trophic changes. Palpation of the peripheral arterial pulses, determination of the skin temperatures, oscillometric studies of the parts involved, and x-ray studies of the extremities by means of flat films and arteriography should be included.

Roentgen studies of the extremities by means of flat films showing the soft parts, are made in order to investigate the conditions of the vessels. With this procedure we can determine whether calcific or atheromatous changes have developed in the vessel walls. In this manner the diagnosis of arteriosclerosis obliterans may be confirmed and early cases of diabetic sclerosis or arteritis recognized. Thromboangiitis obliterans, even in an advanced state will not be demonstrated in this manner. This method does not determine the size of the lumen in the vessels studied, as is obtained by arteriography.

Arteriography is accomplished by the injection of the arteries, particularly the femoral and the brachial, with a medium opaque to x-rays. This is done to determine the presence of thromboangiitis obliterans, arteritis of all types, anomalies, thrombosis, Raynaud's disease, collateral circulation and other abnormalities. In my first work in arteriography in 1926, I used lipiodol for a contrast medium but found it too dense and globular. Now, the most commonly used solutions are thorotrast and diotrast.

Arteriography may be used to decide upon a favorable safe site for amputation. Veal and McFetridge[17] in studying the circulation of patients with gangrene, by this method, were aided in determining whether the circulation was adequate at lower levels, thereby salvaging part of the extremity.

Frequently it is difficult definitely to differentiate the various types of vascular diseases and great care must be exercised in selecting the type of treatment. Often a combination of methods is used at one time, and during any one course of treatment. We often combine diathermy with passive vascular exercises and intermittent occlusion.

In order that effective treament be established and good end results obtained, there must be full cooperation of the surgical, medical and physical therapy departments.

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(Continued from page 340)

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SCIENCE, NEWS, COMMENTS

The American College of Physicians Announces Its Twenty-Sixth Annual Session to Be Held in St. Paul, Minn., April 20-24, 1942

Dr. Roger I. Lee, of Boston, is President of the College, and will be in charge of the program of General Sessions and Lectures. Dr. John A. Lepak, of St. Paul, has been appointed General Chairman, and will be in charge of the program of Hospital Clinics and Round Table Discussions, as well as local arrangements, entertainment, etc. Mr. Edward R. Loveland, Executive Secretary of the College, 4200 Pine Street, Philadelphia, will have charge of the general management of the session and the technical exhibits.

Opening of New Physical Therapy Building at Michael Reese Hospital

The Michael Reese Hospital will open on Sunday, June 15 for inspection by the public, a new building which will provide modern facilities for the treatment of infantile paralysis and of the many other conditions to which physical therapy is applicable. The hours for visitors will be from two-thirty to five P. M. The physical therapy building, to be known as the Alfred C. Meyer Memorial, has been erected to the memory of the late Alfred C. Meyer, who from 1920 to 1936 was President of the Michael Reese Hospital.

The new building adjoins the main one to the north. Its first floor comprises fifteen treatment rooms, including a gymnasium for corrective gymnastics, fever therapy rooms and a hydrotherapy section. The gymnasium is fully equipped for the rehabilitation of paralytic and other cases. The fever therapy unit has the most modern fever cabinets and accessories. The hydro-therapy section comprises equally adequate facilities. The second floor is a continuation of the private room division of the main hospital and represents an eighteen-bed unit for the care of general patients.

It is in the basement, however, that the features perhaps most interesting to the visitor are found, chief of these being the Ervill R. Silberman pool for corrective under-water gymnastics, for the treatment of the effects of infantile paralysis, spastic paralysis, spinal injuries and arthritis. The pool was donated by J. D. Silberman and his son, Donald. The pool and floors are of three toned blue tile, the walls of blue and the windows of translucent block glass. The ceiling is sound-proofed, so that the effect of the whole is decorative, colorful and restful. The equipment of the pool consists of hydraulic tables, belt walking devices, parallel bars, stairs for walking and an overhead lift. Its dimensions are such that the patients as they progress in their exercises may as a curative measure be given the opportunity to swim. To children swimming is offered as a reward for good work. Included in the under-water gymnastic system is a Hubbard tank used chiefly for spastic paralysis cases and for small children recovering from infantile paralysis. In the basement one also finds the brace shop which manufactures and fits braces for crippled persons. This was donated and is sponsored by the Chicago Club for Crippled Children. Of the persons cared for by the brace shop, and by the physical therapy structure generally, including the pool, many are charity cases.

An Appreciation

The Council on Physical Therapy is most desirous of expressing its sincere appreciation to the following consultants who have given so generously of their time and effort during the past year in assisting the Council in its work:

Drs. Fred L. Adair, Howard Ballenger, M. Herbert Barker, Walter M. Boothby, Milton B. Cohen, W. Allen Conroy, Earl C. Elkins, Samuel Feinberg, Hart Fisher, Hubert H. Hathaway, John S. Hibben, Archibald Hoyne, K. K. Jones, Louis Katz, Disraeli Kobak, Arno Luckhardt, Harry E. Mock, Jr., C. O. Molander, Tell Nelson, Benjamin Orndoff, S. L. Osborne, George Shambaugh, Jr., William O'Neill Sherman, E. M. Smith, Kellogg Speed and Grant E. Ward.

Audiometers and Hearing Aids — Drs. C. C. Bunch, George M. Coates, E. P. Fowler, Isaac Jones, Douglas Macfarlan, C. Stewart Nash, Horace Newhart, Paul Sabine, B. R. Shurly, and W. P. Wherry.

Educational Work. — Drs. Frances Baker, Benjamin Boynton, Muriel Case Downer, F. H. Ewerhardt, Richard Kovacs, Fred B. Moor, W. H. Northway, Walter M. Solomon, Arthur L. Watkins, and Walter J. Zeiter.

Roentgen Rays. — Drs. William E. Chamberlain, Arthur C. Christie, E. C. Ernst, Gioacchino Failla, F. M. Hodges, John T. Murphy, Robert C. Newell, Eugene Pendergrass, U. V. Portmann, Lauriston S. Taylor, and J. L. Weatherwax.

Artificial Limbs. — Drs. S. Perry Rogers, Paul Steele, and Philip Wilson, and Messrs. McCarthy Hanger, Sr., W. E. Isle, J. B. Korrady, Joseph Spievak, and David E. Stolpe.

Electrocardiographs. — Drs. A. R. Barnes, George Fahr, Harold E. B. Pardee, W. D. Stroud, Carl J. Wiggers and Frank N. Wilson. — [J. A. M. A. **116**:2501 (May 31) 1941.]

Physical Therapy at 92nd Annual Session

At the 92nd Annual Session of the American Medical Association held in Cleveland, June 2 to 6, 1941, the following papers on physical therapy were presented:

Wednesday, June 4, Section on Dermatology and Syphilology.

"Herpes Simplex Following Artificial Fever Therapy: Smallpox Vaccination as a Factor in the Prevention of Herpes Simplex Occurring After Artificial Fever Therapy," by *Frances M. Keddie, R. B. Rees, Jr.,* and *Norman N. Epstein,* of San Francisco.

Wednesday, June 4, Section on Surgery.

"The Effect of Hot and Cold Applications to the Abdominal Wall and Also Hot and Cold Fluids Administered by Mouth on Gastric and Intestinal Secretory and Peristaltic Activity," by *J. Dewey Bisgard,* Omaha.

Friday, June 6, Joint Meeting with Section on Pharmacology and Therapeutics.

"Physical Therapy in Internal Medicine," by *George Morris Piersol,* Philadelphia.

Friday, June 6, Section on Nervous and Mental Diseases.

"Electrically Induced Convulsions in the Treatment of Functional Disorders," by *David John Impastato,* New York.

Officials Foresee Serious Shortage of Physicists

An acute shortage of physicists for defense work is foreseen by officials here. They are needed for investigating problems of electricity, strength of materials and means of protecting against bombs, mines, etc., as well as new ways of obtaining power.

Colleges will graduate about 250 new physicists this year. We need over 1,000.

An accurate assay of the new reinforcements for Uncle Sam's army of scientific and technical personnel and the extent to which they fall short of meeting immediate requirements of the Government and the defense industries will be available in about three weeks. Replies will then be received to a questionnaire now going out to all college presidents.

The National Roster of Scientific and Specialized Personnel, master list of America's available resources in scientific brains and specialized training, has asked all college presidents to furnish the number of physicists, chemists, psychologists and other scientists they will graduate this spring.

Forms will then be furnished to the colleges to pass on to these graduates, so that they may automatically be added to the National Roster.

In line with President Roosevelt's policy and the action of the Selective Service System in recommending special consideration by draft boards of requests for deferment by students in chemistry, engineering and medicine, it is anticipated that similar recommendations may be made for students in physics, psychology and other sciences where shortages are likely and where the need for additional manpower may seriously delay the defense program.

The shortage of physicists is believed to be much more serious than that likely to occur in chemistry. Fortunately, the United States has large numbers of trained chemists and chemical engineers—a situation attributed to the stimulus of the first World War.

When America entered the War in 1918, the need for chemists was keenly felt. At that time, Germany led in chemical developments. But since that time, we have had more than twenty years in which to train chemists. Today, about 60,000 chemists are already registered in the National Roster.

This War may provide a similar urgency to direct intelligent young students into the field of physics. But up to date, physics has not attracted many. Only 7,000 physicists are now listed in the Roster.

In psychology, the number of available is still smaller. There are only about 3,000 psychologists in the United States. The Government and defense industries are having difficulty in finding enough trained personnel especially in clinical and abnormal psychology, psychological and personnel testing, and in the analysis of propaganda.

Serious shortages also seem to exist in marine engineering and mechanical engineering.

To aid in meeting defense needs, the National Roster is now preparing to list trained personnel in the medical sciences. It is also planned to list motion picture engineers and distributors.—*Science News Letter.*

Thyroid is Fast-Working Organ Radioactive Iodine Shows

The thyroid gland in the throat, which secretes and stores iodine for the body's physiological needs, is a fast-working organ. Six minutes is all it needs to receive and concentrate iodine taken into the blood stream, it is indicated in researches reported before the meeting of the American Association of Anatomists, by Dr. Charles Philippe Leblond and Dr. Pierre Sue, formerly of the Laboratoire de Synthese Atomique at Ivry, France, and now of the University of Rochester.

The two French physiologists used the now familiar technique of tracing elements artificially made radioactive through the bodies of experimental animals. In the present instance, of course, iodine was the radioactivated element empolyed. Within six minutes after it had been injected into the veins of their rats and guinea pigs its concentration in the various body tissues had reached a constant level.

In the thyroid this level was 20 times greater than it was in other body tissues. Within the gland itself the high concentration was altogether in the storage material known as the colloid; the active cells of the thyroid contained no more iodine than did cells of other body parts.

Evidence confirming the belief that the thyroid acts under the physiological direction of the hypophysis, "master gland" located within the skull, was produced when Drs. Leblond and Sue removed this gland from some of their animals.

Items of Interest

Crisfield, Md., packs and ships more *crab meat* than any other locality in the world.

Oranges contain practically no starch, and therefore do not ripen further after they are picked.

"Blitzing" peach orchards with mass liberations of *parasites* is being tried in efforts to fight fruit moths.

New and old *potatoes* may differ in flavor, but nutritionists have not found much difference in food value.

Soybean oil is likely to prove useful in paint for traffic lines, now that science has found out how to make it dry quickly.

A new ship for North and for South American travel will be the first ocean liner completely *air-conditioned* in all passenger cabins.

One king of ancient Egypt, says an Egyptologist, had represented on his tombstone his favorite *dogs:* Gazelle, Greyhound, Black and Fire-Pot.

Pennsylvania is having a "back-to-the-country" trend in *population,* but not back to the land, because little towns rather than farms are the goal.

Reminiscent of *war gardens* of 1918, demonstration vegetable gardens are being planted in four New York counties by state agricultural agents this spring.

Sugar maple trees with large tops yield sap of about 1% higher sugar content than other trees, according to an experiment.

Careless handling between henhouse and retail counter probably does more to lower *egg* quality than anything else, says a government agricultural writer.

Evolving a machine to crack *coyol* nuts has given Mexico a new industry — the nuts, growing on a palm tree, offer a substitute for coconut oil in soaps and margarines.

Intended to check wind erosion, wild plum and chokecherry *thickets* in North Dakota are also providing fruit for jelly making and shelter and food for useful birds.

The Queen Elizabeth Wore a "De-Gaussing Girdle"

News that the British are using a new and secret type of mine in their reported 60,000 square miles of mine fields off the German, Netherlands and Norwegian coasts may mean that British scientists have played a major role in offensive mine warfare, just as they helped to conquer the menace of the magnetic mines, sprung on the Allies by Germany a few months ago. In the case of the magnetic mines, British specialists in magnetism left their regular scientific investigations in order to develop protection for ships against the magnetic mines. The nature of this protection became known when the Queen Elizabeth arrived at New York with a "girdle" around her hull. The girdle supplied with electric current of the necessary strength and characteristics, sets up a magnetic field which in association with the steel hull and other magnetic material of the ship is such that magnetic mines laid at sea are not set off by the passage over them of a vessel so equipped. The expressive name applied to this protective device is "de-gaussing girdle." It is named after the unit of magnetic flux density. This honors a great German scientist, Carl Friedrich Gauss (1777-1855), known as the "prince of mathematicians," who in addition to being responsible for the theory of probability (not without its application to mining operations!) did fundamental work in electrodynamics. — *Science News Letter.*

Tuberculosis Is Fought Among Defense Workers

Uncle Sam is going to great lengths to make sure that among the million or more young men in army training camps there will be none whose health is not good enough to stand the rigorous life and activities of a soldier in training.

Behind the training camp front is another vast and growing army of men and women working in the factories that produce defense weapons. They also are subject to certain strains on health and endurance, strains which will be increased by the speed-up of production for defense. These extra strains, plus the fact that many of the industrial workers will be living in crowded quarters, at least temporarily, and may be deprived of certain necessities by mounting prices, are conditions that threaten health in many ways and particularly carry the threat of increased spread of tuberculosis.

The way to stop the spread of tuberculosis is to find the people who have the disease and keep them from contact with others while the disease is in the infectious stage. In the early stages of this disease, however, the patient often does not know he has it. In fact, he may not even feel sick. So he fails to get treatment for himself at an early stage when it can be most helpful, and fails to stop the spread of his germs to other persons.

In this early stage, long before the patient is coughing or spitting blood or having night sweats or feeling tired, x-ray pictures can detect the disease. Consequently, tuberculosis authorities urge more widespread use of x-rays to find the patients who need treatment and to check the spread of tuberculosis.

The National Tuberculosis Association is conducting its annual Early Diagnosis Campaign, to remind people generally of the importance of finding the unsuspected tuberculosis patients in every community and every home.

One place to start looking for unsuspected tuberculosis, the association believes, is in the army of defense industry workers.—*Science News Letter.*

Ultrashort Waves Detect Airplanes at Night

Radio waves about 20 inches long form the fingers which detect invisible airplanes at night, according to a new invention just granted patent 2,231,929 by the U. S. Patent Office. This patent went to Joseph Lyman, of Huntington, N. Y., who assigned it to the Sperry Gyroscope Co., Inc., of Brooklyn.

Repeatedly reports have come from England that R.A.F. fighter planes have some new equipment enabling them to detect Nazi bombing planes in full darkness. The exact nature of the device has not been revealed but, judging by Mr. Lyman's description of his invention, it might serve the purpose.

"The novel indicator," he states in the specifications, "is adapted for use on aircraft either for indicating the direction of approach of other aircraft, to thereby prevent collision under conditions of poor or zero visibility, or for use on the ground as when locating aircraft for purposes of gunfire control, or for controlling aircraft landings from the ground, and for other purposes."

He suggests the use of signals of 600 megacycles, or about 20 inches wavelength, because these can be generated and detected by simple means, and are not greatly interfered with by natural phenomena, such as solar radiation. These are about a hundredth of the wavelength of the 6 megacycle signals used for transatlantic short wave broadcasts.

The apparatus consists of a receiving antenna in a parabolic reflector which sweeps around several hundred times a second. At the same time, the axis of rotation itself turns, but more slowly, so that the antenna sweeps all the way around. Because of the reflector it will only receive signals originating in the direction to which it is pointed. Instead of one such antenna, two can be used, one sweeping vertically, the other horizontally.

In peace time, the approaching airplane might have its own transmitter and send out a continuous warning. Since enemy bombers would hardly be so obliging, however, it can also operate with a transmitter on the defending plane, since the other would reflect the waves from its metal shell. In either event, the receivers pick up the signal only at one instant in their sweep, and this is shown by a spot of light on the end of a cathode ray tube, like that used in television receivers. The position of the spot shows the exact direction of the other plane.

For fire control from the ground, where more bulky equipment may be employed, parabolic transmitting antennas are also used, which turn in step with those of the receiver. This is more efficient, because the signals are sent only in the direction where they will be detected, not broadcast.—*Science News Letter.*

Effect of Short Wave Diathermy on Intestinal Activity — McLoughlin, et al.

(Continued from page 332)

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THE STUDENT'S LIBRARY

METHODS OF TREATMENT. By *Logan Clendening*, M.D., Clinical Professor of Medicine, Medical Department of the University of Kansas; Attending Physician, University of Kansas Hospitals; and *Edward H. Hashinger*, A.B., M.D., Clinical Professor of Medicine, Medical Department of the University of Kansas; Attending Physician, University of Kansas Hospital, etc. With Chapters on Special Subjects by Twelve Authors. Seventh edition. Cloth. Pp. 997 with 138 illustrations. Price, $10.00. St. Louis: C. V. Mosby Company, 1941.

The popularity of Clendening as a teacher and writer on medical subjects is attested by the fact that this volume has now entered into the seventh edition of what must be regarded as an elaborate and much expanded discussion on the important and practical topic of methods of treatment. It should be pointed out that outside the fact that this edition is a radically revised and improved contribution, it contains the interesting advent of a special collaborator, Edward H. Hashinger, whose active clinical experience as a teacher qualifies him to the status as the junior partner of what is hoped will be the beginning of a valued literary combination. It may be of further interest to point out that the authors spared no effort to bring the many new problems in therapy so down to date as to provide space for original discussions by twelve special collaborators, as well as the material and advice of others on topics to which their names give them authoritative status. In many instances sections have been entirely recast or completely rewritten. A number of new chapters have been included on subjects as timely as that of chemotherapy for coccal diseases; the management of that all too frequent problem of backache; the treatment of peripheral vascular diseases, as well as some that offer clearer orientations on the treatment of gout, the values of anesthetics and the like. The chapters on artificial pneumothorax and diseases of the esophagus have been entrusted to new hands (Drs. Wood and Knight, respectively), and are entirely original. Among the group of newer drugs discussed are those of coramine, heparin, benzedrine, dilantin, aluminum hydroxide, Karaya, Cerophyll, and Klotogen. It also includes a special review of many endocrine products and vitamins. To be sure, while in many of the diseases discussed the treatments recommended are conservative and infrequently outdated, in most respects the work is well revised and presents down to the minute information. The sections on physical procedures supply essential information of the more standard technics in hydrotherapy, the local application of heat and cold, massage, exercise, electrotherapy, diathermy and the like. These portions of discussions have been provided by Drs. Leland F. Glaser and Carl O. Rickter. Climatotherapy with its broad application in health resorts has been written under supervision or advice of Drs. Euclid M. Smith and Walter S. McClellan and is thus representative of the best traditions in scientific practice in this much abused and misunderstood medical terrain.

METHODS OF ANATOMY. DESCRIPTIVE AND DEDUCTIVE. By *J. C. Boileau Grant*, M.C., M.B., Ch.B., F.R.C.S. (Edin.). Professor of Anatomy in the University of Toronto. Second Edition. Cloth. Pp. 794 with 651 illustrations. Price, $6.00. Baltimore: *A William Wood Book*. The Williams and Wilkins Company, 1940.

The sincerest compliment that can be paid to a scientific textbook is to make use of it according to purposes suggested by the author. That teachers, students and physicians have been quick to appreciate and adopt the new method of study of human anatomy as described by Grant is demonstrated by the necessity of a new edition and its presentation in the present thoroughly revised and greatly enlarged text. As already indicated in a previous review, the style followed by Professor Grant is somewhat akin to a pleasant "journey of exploration through the territory of the human body." Surprising it is how such a formidable and often dull a subject as the study of anatomy (to the average student) can under easy guidance of a master prosector become so colorful, interesting and meaningful. The new edition represents the rounded out effort of one of our foremost instructors in this field. It has attempted to fill in the inadvertent gaps of the previous edition and meet all the requirements of the medical student. Ambiguous sentences and paragraphs that were an annoyance in the past have been clarified, and new illustrations and subdivisions included at the expense of extra pages. Thus it is noted that more than a hundred new illustrations have been added to the present text as well as old ones improved or replaced, raising the total number to 651. Among other innovations is an introductory section, short and informative, which provides an orientation of the historic background to its antiquity, classicism and purpose. Altogether the work is an impressive, compact and authoritative contribution, easy of understanding and practical in character. It is predicted that this book will make anatomy a more rational and interesting study and will be used by physicians to correlate their medical and surgical problems. The publishers are to be complimented for their splendid cooperation.

DISEASES OF THE DIGESTIVE SYSTEM. By *Sidney A. Portis*, B.S., M.D., F.A.C.P., Associate Clinical Professor of Medicine, Rush Medical College of the University of Chicago; Attending Physician, Michael Reese Hospital, etc. Cloth. Pp. 952 with 176 engravings. Price, $10.00. Philadelphia: Lea & Febiger, 1941.

Within the past few decades gastroenterology has succeeded in bridging the gap between medicine practiced as an art and as a science. This rapid development, however, has not taken place without certain faults, and as a consequence the record of its progress has been somewhat disorganized. Evidence of this fact is provided by a cursory review of contributions to the gastroenterological literature, which indicates the relative scarcity of organizational effort to place the accumulated information in textbook form. To be sure, certain parts of the subject have been covered by monographs and works on particular phases of this practice in which diseases of the gall bladder or the intestines are notable examples. However, the subject as an entirety has never in recent years been satisfactorily correlated as in the present contribution. In "Diseases of the Digestive System," a distinguished group of collaborators has attempted to rectify this situation. Under Portis' editorship there is now within reach a volume replete with excellent chapters on the varied aspects of this extensive subject. As one might expect in a work of this detailed character a few chapters have fallen below the standard set by the majority of authorities. The chapter on diseases of the small intestine is an example in point. The work with minor exceptions however is a splendid example of what may be accomplished under wise editorial supervision and special collaboration. In most respects it succeeds well in its purpose of presenting a coordinated, scientific view of available knowledge on diseases of the digestive system. Of particular interest are the chapters bearing on the relation of various other specialties to gastroenterology. One's interest is not only held firmly throughout the sections on anatomy and physiology but in general the discussions are presented in such lucid and coherent style as to make this volume the choice of authoritative reading for the profession. The correlation of the interrelated problems have been handled in an excellent fashion.

WILLIAMS' OBSTETRICS. A TEXTBOOK FOR THE USE OF STUDENTS AND PRACTITIONERS. By *Henricus J. Stander*, M.D., F.A.C.S., Professor of Obstetrics and Gynecology, Cornell University Medical College, etc. Eighth edition. Cloth. Pp. 1401 with 704 illustrations, 13 in color plates. Price, $10.00. New York and London: D. Appleton-Century Company, Inc., 1941.

It is not without ample reason that students have sought Williams' textbook of obstetrics for more than a generation, for in this work essentials of obstetrical knowledge have been presented in a manner both comprehensive and understanding. Through this enviable period which has seen the printing of eight editions, the text has not only continued to be a leading guide but with the advent of Stander's authorship has been given new life and scholarship. In this edition old chapters have been revised, new ones added and in general, has been brought completely down to date. Such new chapters as "Diseases and Abnormalities of the Newly Born Child," "Classification of Abnormal and Contracted Pelves," and "Sudden Death and Maternal Mortality," provide practical information to an already valuable work. The section on embryology has been revised in conformity with the newer concepts of Streeter and his school and is presented in concise and lucid style. Varied improvements have likewise been introduced into the sections on roentgen ray. The mechanisms of labor, the classification of contracted and abnormal pelves, and pelvimetry are discussed from every aspect including the roentgenologic viewpoint. The toxemias of pregnancy are classified and discussed according to the new classification of the American Committee on Maternal Health, in a fashion that promises to make this chapter the very classic in its field. The newer technics of cesarean section are considered, and treatment of puerperal infection and other gestation infection have taken cognizance of the latest concepts of chemotherapy. The chapters on diseases of the urinary system and endocrine function have been virtually rewritten.

From the student's viewpoint this new work contains that appeal which stems from ample, authoritative knowledge presented in a comprehensive and clear style. From the viewpoint of the teacher and practitioner this work offers the additional attraction of a text as artistic in format as it is authoritative in content. It is a fitting successor to the long line of Williams' texts.

INTERNATIONAL ABSTRACTS

Production of Ventricular Fibrillation by Alternating Currents. René Wégria, and Carl J. Wiggers.

Am. J. Physiol. **131**:119 (Nov. 1) 1940.

Wégria and Wiggers analyze the effects of 60 cycle alternating currents applied locally to the dog's left ventricle through nonpolarizable electrodes. The response is usually one or two premature ventricular systoles followed or not by ventricular fibrillation. If the stimulus is introduced during diastole, it causes one premature beat and never produces fibrillation. The occurrence of fibrillation by early diastolic shocks, incapable of acting during the vulnerable period, can be explained by the fact that an effective portion of the series now falls during the vulnerable period of a premature beat. In other words, an apparent diastolic fibrillation is actually a fibrillation started during the systolic vulnerable period of a premature beat.

A. C. stimuli, with durations varying from 0.2 to 1 second or more, promptly cause fibrillation when currents are of moderate or great strength. However, even very weak currents (0.5 to 1.0 ma.) cause ventricular tachycardia which may revert to a normal rhythm after removal of the stimulus or may eventuate in fibrillation either while the a. c. is operating or shortly after its withdrawal. The reason why weak alternating currents produce fibrillation in some tests and not in others remains obscure. However, definite evidence is presented that the duration of such currents is not a factor provided this exceeds 0.2 sec. The mechanisms through which fibrillation eventuates during or shortly after use of such weak a. c. currents are difficult to analyze on the basis of evidence so far available.

Heat Exchange and Regulation in Radiant Environments Above and Below Air Temperature. C. E. A. Winslow; A. P. Gagge, and L. P. Herrington.

Am. J. Physiol. **131**:79 (Nov. 1) 1940.

A new experimental booth is described, which provides more accurate control of the various experimental variables in heat interchange than was previously possible. Radiation areas as determined in this new booth are found to lie between 70 and 75 per cent of the DuBois area. Convection constants are found to lie close to a value of 1.0 multiplied by the square root of air velocity in centimeters per second. It is shown that, when the body is subjected to markedly cold or hot conditions, storage cannot be estimated from changes in skin temperature and rectal temperature. Both these temperatures may be maintained by the vaso-motor system at a stable level for considerable periods, in spite of the fact that appreciable heating or chilling of less vascular tissues is taking place. Storage, under such conditions, can be measured most adequately by difference — from the algebraic sum of metabolic heat production, evaporative heat loss and gain, or loss by radiation and convection.

So far as cold-wall hot-air situations and equal wall and air situations are concerned, physiologic responses exactly follow operative temperature (as computed from mean radiant temperature and radiation area combined with air temperature, air movement, and convection constant). With a cold-air hot-wall situation, however, skin and rectal temperature are somewhat lower—for a given operative temperature—than with equal wall and air or with hot-air and cold walls. The difference is slight (0.5-1.0 degrees) and can be accounted for by the cooling effect of the cold air upon the membranes of the nose and throat, and, perhaps, also by additional heat loss to the metal supports of the subject's chair and to increased convective heat loss due to movements of the arms and legs.

Uveitis. A. D. Ruedemann.

Cleveland Clin. Quart. **8**:58 (Jan.) 1941.

The diagnosis of uveitis, especially of the low-grade recurring type, is one of the most exacting problems in medicine. Difficult to diagnose, difficult to treat, and offering a very poor prognosis, uveitis comprises one of the largest groups of ophthalmologic cases. In any case of uveitis with a transitory stage of secondary glaucoma, especially when there is degeneration of the pigment of the iris or a low-grade exudative process, the use of local heat in the form of hot compresses and deep heat in the form of diathermy is of benefit to some of these patients. If there is deep-seated inflammation, heat treatment not only makes the patient more comfortable, but also aids the healing process.

Studies on Photosynthesis. Jack Myers, and G. O. Burr.

J. Gen. Physiol. **24**:45 (Sept.) 1940.

The effect on oxygen evolution of Chlorella vulgaris produced by light intensities up to about 40,000 f.-c. has been studied by the Warburg technic. Above a certain critical intensity, which is determined by the previous history of the cells, the rate of oxygen evolution decreases from the maximum to another constant rate. This depression is at first a completely reversible effect. With a sufficiently high intensity this constant rate represents an oxygen uptake greater than the rate of dark respiration. During such a constant

rate of oxygen uptake a progressive injury to the photosynthetic mechanism takes place. After a given oxygen consumption the rate falls off, approaching zero, and the cells are irreversibly injured. The constant rate of oxygen evolution (*2* and *3*) decreases in a continuous manner with increasing light intensities, approaching a value which is approximately constant for all cells regardless of previous history. Two alternative hypotheses have been presented to explain the observed phenomena. The more acceptable of these proposes quick inactivation of the photosynthetic mechanism, the extent of inhibition depending on the light intensity.

Effect of Iontophoresis on Eyes With Special Reference to Intraocular Tension. William Thau, and Abraham Myerson.

Arch. Ophthal. **24**:4-761 (Oct.) 1940.

Iontophoresis exerts a general parasympathetic effect manifested as a slight narrowing of the palpebral fissure, a lessening of the size of the pupil, some anterior projection of the lens and a definite and durable dropping of the intraocular tension. These results were obtained consistently and repeatedly on four patients with tractable dementia praecox. When the positive electrode is applied over the eye, the effects last from five days to a week, while the negative electrode so placed produces a reaction lasting six to nine days.

The lowered intraocular tension thus obtained is much more durable than that obtained by medication, since any drug now in use has effects that last only a few hours. Repeated experiments on the same persons have shown no dangers from iontophoresis, if the electrode is kept from contact with the cornea. Necessarily, the electrode must be kept constantly moistened with normal salt solution.

With the positive electrode the ions of the salt solution discharged into the eye are the sodium ions. However, if the negative pole is used the chloride ions enter the local structure of the eye. Thus, negative and positive charged ions seem to produce the same general results. The effect may possibly be a stimulation of the ciliary muscle by the parasympathetic nerve and may be linked up with the increased blood flow, as evidenced by dilatation of the capillaries, or may have reference to some obscure and less ascertainable chemical changes within the reacting cells themselves. Whatever the mechanism, the effect seems worthy of extension to include the treatment of glaucoma. It is likely that iontophoresis will produce a more marked reduction in the pathologic than in the normal eye.

Conferences on Therapy.

New York State J. Med. **40**:1737 (Dec. 1) 1940.

Three years ago a series of therapeutic conferences was started for the purpose of instructing students at the Cornell University Medical College, but their function has broadened and they now serve an important role in the exchange of views between different departments in the institution, and they are largely attended by the attending and house staffs. These conferences are conducted jointly by the Department of Medicine and Pharmacology with the collaboration of other departments and institutions. Dr. Niles discussed the management of fever in general and did not include the treatment of any specific febrile diseases. He pointed out that fever induces a rapid loss of water from the body, which must be compensated. He recalled the teachings of Du Bois, who stressed that the best way to guide adequate fluid intake is by observing the urine, to see that it is dilute and colorless. Nowadays, we seldom attempt to control fever by administering antipyretics, and hydrotherapy is far less frequently employed than heretofore. Formerly, much of the time of the nursing staff was taken up in giving baths of some sort, but now, aside from the daily hygienic bath, comparatively few patients receive hydrotherapy. Niles felt that the best guide for prescribing hydrotherapy is not so much the height of the fever but rather the comfort of the patient.

Treatment of Mental Disorders with Pharmacological and Electrical Shock Methods. Nathaniel J. Berkwitz.

Minnesota Med. **24**:25 (Jan.) 1941.

The writer believes that all forms of pharmacologic and electrical shock therapy produce similar effects since all are psychophysiologic methods. Two conditions are known to occur: (1) powerful stimulation of the autonomic nervous system, followed by (*2*) depression or temporary inhibition of the higher cerebral centers. Increased pulse rate, elevation of the blood pressure, dilatation of the pupils, flushing of the skin, and increased salivation are some of the evidences of stimulation of the autonomic nervous system. After this stimulation the higher centers are depressed or temporarily paralyzed by the resulting coma or unconsciousness in pharmacologic and electrical-convulsive shock therapy.

In a search to find a safe and better controlled substitute for pharmacologic and electrical-convulsive shock, the writer devised a method which he believes can produce similar effects by safer means. For stimulation, a faradic current well within the margins of safety is used in place of drugs. This current is not strong enough to produce convulsions or irreversible physiologic changes. Immediately following a brief series of electrical shocks which are applied to the patient's head, a barbiturate (pentothal sodium) is administered intravenously for quick anesthesia.

All forms of shock treatment should be considered merely as an adjuvant to psychotherapy. Other forms of psychotherapy are essential. Shock treatment may relieve the patient of acute psychotic symptoms, but it does not materially alter his constitutional makeup.

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